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IN THIS ISSUE

- HAND INJURIES IN A STEEL PLANT ..... *Joseph B. Tauber, M.D.*
- CERTIFICATION IN OCCUPATIONAL MEDICINE
  - I. Backgrounds and Policies Involved in Certification ..... *Robert A. Kehoe, M.D.*
  - II. Nature and Objectives of the Specialty ..... *James H. Sterner, M.D.*
  - III. Qualifications of the Certified Specialist ..... *A. G. Kammer, M.D.*
- THE DETERMINATION OF INJURY FROM THE INTERNALLY DEPOSITED RADIOISOTOPE PLUTONIUM ..... *W. Daggett Norwood, M.D*
- INDUSTRY'S ROLE IN MENTAL HYGIENE ..... *Gerald Gordon, M.D.*
- TOPICAL REVIEWS
  - Hydrogen Cyanide—Hazards, Toxicology, Prevention and Management of Poisoning ..... *Jack H. Wolfsie, M.D., and C. Boyd Shaffer, Ph.D.*
  - Industrial Medical Aspects of Nuclear Technology—
    - II. Some Fundamentals of Nuclear Physics and Radiation Measurements ..... *Niel Wald, M.D.*

Complete Table of Contents on Page *3a*

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Journal of Occupational Medicine

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TABLE OF CONTENTS

TEXT SECTION

Original Articles

HAND INJURIES IN A STEEL PLANT—ANALYSIS OF 15,000 CONSECUTIVE CASES 255
Joseph B. Tauber, M.D.

CERTIFICATION IN OCCUPATIONAL MEDICINE

I. BACKGROUNDS AND POLICIES INVOLVED IN CERTIFICATION 262
Robert A. Kehoe, M.D.

II. NATURE AND OBJECTIVES OF THE SPECIALTY 264
James H. Sterner, M.D.

III. QUALIFICATIONS OF THE CERTIFIED SPECIALIST 267
A. G. Kammer, M.D.

THE DETERMINATION OF INJURY FROM THE INTERNALLY DEPOSITED RADIOISOTOPE PLUTONIUM 269
W. Daggett Norwood, M.D.

INDUSTRY'S ROLE IN MENTAL HYGIENE 277
Gerald Gordon, M.D.

Topical Reviews

HYDROGEN CYANIDE—HAZARDS, TOXICOLOGY, PREVENTION AND MANAGEMENT OF POISONING 281
Jack H. Wolfsie, M.D., and C. Boyd Shaffer, Ph.D.

INDUSTRIAL MEDICAL ASPECTS OF NUCLEAR TECHNOLOGY—II. SOME FUNDAMENTALS OF NUCLEAR PHYSICS AND RADIATION MEASUREMENTS 289
Niel Wald, M.D.

Editorials

PLUTONIUM TOXICITY 296

FIRST LADY OF INDUSTRIAL HYGIENE 296

CHANGE OF PLANS 297

The President's Message 298

Book Reviews 299

Abstracts

DERMATOLOGY 301
William R. Buckley, M.D.

MEDICAL CARE ADMINISTRATION 302
Asa Barnes, M.D.

INTERNAL MEDICINE 303
Shermer Stradley, M.D.

EXPERIMENTAL TOXICOLOGY 305
Robert E. Eckardt, Ph.D., M.D.

REPARATIVE SURGERY 306
Robert J. Trettin, M.D.

CLINICAL TOXICOLOGY 308
Lee H. Miller, M.D., I.M.D.

INDUSTRIAL HYGIENE 309
Edward C. Riley, M.D.

RADIATION HEALTH 310
Thomas S. Ely, M.D.

NOISE AND HEARING 312
H. O. Parrack, Ph.D.

MENTAL HEALTH 313
Graham C. Taylor, M.D.

GENERAL SECTION

Industrial Medical Association

OFFICERS AND DIRECTORS *6a*

About the Authors *15a*

People and Events *17a*

List of Advertisers *20a*

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The Industrial Medical Association was organized in 1915 as the American Association of Industrial Physicians and Surgeons. Its first annual meeting was held the following year. In 1951 the present name was adopted.

The purposes of the organization as stated in the certificate of incorporation (not-for-profit) are:

"The object of this Association will be to foster the study and discussion of the problems peculiar to industrial medicine and surgery; to develop methods adapted to the conservation of health among workers in the industries; to promote a more general understanding of the purposes of the medical care for employees; and to unite into one organization members of the medical profession specializing in industrial medicine and surgery for their mutual advancement in the practice of their profession."

Presently, the membership totals nearly 4000 physicians in the United States, Canada, Latin America, and other parts of the world. Physicians "who have an interest in Industrial Medicine" may apply for membership; specialization in this field is not essential. Regionally, the Industrial Medical Association has 14 Component Societies in the United States and one in Hawaii. Most Association members carry their membership through one of the component groups.

The Journal of Occupational Medicine, owned and published by the Industrial Medical Association, is sent monthly to each member as one of the advantages of membership.

The annual business meeting and convention is held in the spring. Since 1945, the convention has been held concurrently with the meetings of four other organizations having related interests—American Industrial Hygiene Association, American Conference of Governmental Industrial Hygienists, American Association of Industrial Nurses, Inc., American Association of Industrial Dentists. This combined meeting is known as the Industrial Health Conference.

The Occupational Health Institute, Inc., is a nonprofit educational organization created by the Industrial Medical Association to promote the cause of health in industry. Since 1951, the Occupational Health Institute has conducted the program of evaluation, approval and certification of Medical Services in Industry, on the basis of standards established by the Standards Committee of the Industrial Medical Association. This program was conducted by the American College of Surgeons for many years until its transfer to the Association.

The Association's headquarters office serves as a focal point for the Association's activities, and through its coordination of information regarding industrial health problems encountered throughout the country, it offers invaluable assistance to members on a host of specific subjects.

ANNUAL MEETING & INDUSTRIAL HEALTH CONFERENCE

War Memorial Auditorium, Rochester, N. Y. **April 26 to 29, 1960**

Association Activities

Dr. Edward C. Holmblad Honored at Annual Banquet Upon Retirement as Managing Director

EDWARD C. HOLMBLAD, M.D., retired as Managing Director of the Industrial Medical Association on April 30, 1959. The occasion was the principal topic of the Association's Annual banquet program on the preceding night. A highlight of this program was the presentation to DR. HOLMBLAD of the Citation of the President's Committee on Employment of the Physically Handicapped made by DR. ROSS T. MCINTIRE, Executive Secretary, International College of Sureons, on behalf of GENERAL MELVIN J. MAAS, Chairman of the President's Committee. Of great interest was a succession of short testimonial talks of 15 past presidents of the Association, and by DR. VOLNEY S. CHENEY, the secretary from 1933 to 1941.

DR. HOLMBLAD'S retirement came as the first result of the Association's new policy of pensioning its managing personnel at the age of 65, and coincided with the end of the Association's annual meeting. When news of DR. HOLMBLAD'S impending retirement became generally available, his services were at once sought by several organizations. In keeping with his deeply rooted determination to be of service to society and particularly to its afflicted members, he accepted an offer to become Medical Director of the Public Aid Commission of the State of Illinois. Despite his determination to take a well-deserved rest before assuming other duties, he responded to the urgent need for his help in the new post and, characteristically, went there to work within 12 hours of his last chores as the Association's Managing Director. His new affiliation is in keeping with an interest in rehabilitation that has grown over the years and which found increasing expression in the volunteer services which he has provided to the Rehabilitation Institute and to Goodwill Industries in Chicago. His new business address is 160 N. LaSalle Street, Chicago.

It is difficult to set a precise time of onset of DR. HOLMBLAD'S service to the Association. Roughly, there were three periods of increasing activity and responsibility. During the 1920's he was an active member and committee worker of the old American Association of Industrial Physicians and Surgeons—the earlier name of the Industrial Medical Association.

A second period, roughly, the 30's, coincided with DR. HOLMBLAD'S more conspicuous identification with the industrial group. This period saw him elected to the offices of president and director. It was a period, also, during which his expeditious performance of the administrative tasks of the Association led to his receiving an ever-increasing number of such tasks to do. Although he still was not in name the Managing Director, he did fill this post in fact. This was done without compensation, as a result only of his affection for the group and his close identification with its principles.

The third and final period spanned almost 20 years. In 1941 he became the Association's first Managing Director, and increasingly became its personification. He saw more clearly perhaps than anyone else the Association's destiny as an instrument for use by growing thousands of industrial physicians, to speak and act effectively in the furtherance of a special kind of medical practice that would have increasing meaning for our industrial society. Within this Association, such men would find the forum in which to propound their principles and the collective strength to make these meaningful. The period is marked by the development of a wide acquaintance among physicians interested in industrial practice, an achievement which came easily as a part of DR. HOLMBLAD'S natural friendliness. With the passage of time he became the counselor of uncounted numbers of such men and women, to whom his name soon became the informal "Ed." His wide and personal acquaintance with the Association's constituents provided him with an unerring grasp of the problems of practice as they were experienced at the grass roots.

In order that Dr. Holmblad might select a retirement gift of his own choosing, his many friends contributed to a purse that exceeded one thousand dollars. Dr. Shilling presents the check.

Dr. McIntire presents Dr. Holmblad with a Citation from The President's Committee on Employment of the Physically Handicapped.

His dependable sources of information and his capacity to develop judgments on a rich background of experience served to establish him as the reliable advisor to the Association's officers for almost a quarter of a century. He was during this time decreasingly in industrial practice, although never entirely out of it; and he found time to pull an impressive oar in a list of community activities such as Boy Scouts of America and the Rotary International. In 1950, he was awarded the Industrial Medical Association's highest honor, the Knudsen Award.

DR. ROSS T. MCINTIRE'S remarks in connection with the President's Citation were in part as follows: "Rehabilitation is coming into its own, not only in our country but throughout the world. Ed is being honored tonight for his contribution in this field. ED HOLMBLAD is Chairman of the Medical Committee of the President's Committee, which is made up of outstanding doctors of medicine in this country. His contribution had a great effect in every state and territory of the Union. From our Medical Committee we are able to influence the thinking of doctors in all of our communities. You who belong to this Association should do everything possible to influence those who must supplement the work of industrial physicians in examining the physically handicapped people for employment after rehabilitation. DR. HOLMBLAD has done a great thing in the leadership he has given. This Citation is awarded in the name of a great group, the people in this country who voluntarily give time and effort in the work to help those who are not quite so fortunate as we. It is signed for the President's Committee by GENERAL MELVIN J. MAAS."

The program of testimonials by the largest assembly of the Association's past presidents was presided over by DR. JEROME W. SHILLING, the most recent member of the emeritus group. In terms of years lapsed since presidency, the oldest ex-officer present was president in the 1926-27 fiscal year. Himself a retiree who has won distinction in a second field of work, DR. WILLIAM A. SAWYER spoke warmly of DR. HOLMBLAD in words which were heartily seconded by the whole group. In part, DR. SAWYER said: "A generation ago when I came into this Association the dues were $3.00 a year, and we had about 200 members. This organization has made terrific strides and I am proud to be a part of it. The reason this Association is what it is today is due to ED HOLMBLAD. It took on body and stature when he took hold of it. Right along with him has been Lillian. I always picture them as the heart and soul of this splendid organization. God bless both, and the best of luck to you."

Several of the past presidents were unable to attend, and sent telegrams of good wishes. Such wires came from DRS. HARRY E. MOCK, CLARENCE D. SELBY, HARVEY BARTLE, FREDERICK W. SLOBE, and HAROLD A. VONACHEN.

DR. VOLNEY S. CHENEY, who for years was the Association's perennial secretary, came from his place of retirement in Albuquerque, to pay tribute to his close associate. The testimonial program was concluded with short talks by DRS. FLOYD E. SHAFFER, ROYD R. SAYERS, MCIVER WOODY, T. LYLE HAZLETT, MELVIN N. NEWQUIST, HENRY S. BROWN, ALFRED H. WHITTAKER, EDWARD H. CARLTON, A. G. KAMMER, E. A. IRVIN, GEORGE F. WILKINS, KIEFFER DAVIS, and E. S. JONES.

DR. HOLMBLAD will continue to serve the Association in the capacity of Consultant, and in keeping with his determination to lead an active and full life, he has accepted the Chairmanship of the IMA Committee on Geriatrics and Retirement.

Election Results
New Appointments

Officers elected at the annual business meeting are as follows: D. JOHN LAUER, M.D., President; R. E. ECKARDT, M.D., President-Elect; GRADIE R. ROWNTREE, M.D., First Vice President; H. GLENN GARDINER, M.D., Second Vice President; LEONARD ARLING, M.D., Secretary; and JOHN L. NORRIS, M.D., Treasurer.

Directors elected for the term 1959-1962 are EDWIN DEJONGH, M.D., JAMES P. HUGHES, M.D., LOGAN ROBERTSON, M.D., RICHARD C. SWAN, M.D., and L. HOLLAND WHITNEY, M.D. O. TOD MALLERY, M.D., was elected to fulfill the unexpired term of DR. GARDINER.

By action of the Board of Directors, CLARK D. BRIDGES became Managing Director of the Industrial Medical Association as of May 1. He has served as Assistant Managing Director since January, 1958. The Board also named RITA KIRTLEY PACKER as Assistant Managing Director. MRS. PACKER was formerly Executive Secretary of the Association.

Journal of Occupational Medicine

Hand Injuries in a Steel Plant

ANALYSIS OF 1,500 CONSECUTIVE CASES

Joseph B. Tauber, M.D., Dr. P.H., Aliquippa, Pennsylvania

THE CARE of serious injuries of the hand requiring surgical treatment in hospitals has received much attention in the surgical literature; but very little serious study seems to have been made of the minor hand injuries that continue to make up a substantial proportion of all cases treated in the medical departments of certain industries of which steel manufacturing is an example. Because of this lack, it seemed desirable to conduct a study of a suitable sample of hand injury cases. Hand injury, as used here, is intended to include all injuries of the wrist, hand proper, and fingers.

Limited objectives were defined for the study. These included a classification of the injuries sustained, according to diagnosis and severity; an analysis of the treatment resources required for the satisfactory management of the kinds of cases under consideration; and a limited characterization of the population under study, in terms of age and sex and such other personal qualities as might be deduced from readily available records.

The case experience chosen for study developed in a steel plant during the first half of 1956. During this period some 14,000 persons were on the payroll, of whom about 3% were women. A large proportion of employees worked a rotating shift schedule; so that the work force on week days averaged about 10,000 persons. The plant comprises 15 major departments, including blast furnace, steel works, blooming mills, wire-rod-and-nail mills, and by-products.

The medical facilities at the plant consist of a central health department and three outlying dispensaries, all served by a full-time organized staff. The health center has an emergency surgery room, recovery rooms, an x-ray unit, and a reasonably well outfitted physiotherapy section. The outlying dispensaries are equipped for the provision of minor treatments only, and have no x-ray units. All of these facilities are staffed by registered nurses during regular day shifts. During all other shifts nurses are in attendance only at the health center and one outlying dispensary. Staff physicians are in attendance from 8:00 A.M. to 5:00 P.M. on week days, and on-call responsibility at all other times is rotated among them.

Injuries considered to be minor and probably uncomplicated are treated by the plant staff, the more serious cases being referred to a surgeon outside the plant. Cases which are treated in the plant include skin lacerations, fractures of phalanges without displacement of fragments, and minor burns. Lacerations involving, or suspected of involving, muscles, tendons, or nerves are routinely referred to the surgeon, who decides as to the need for hospitalization.

Case Material

During the first six months of 1956 there were 6,132 injuries of all types at the plant under study. Of these, 2,769, or 45%, were in-

Dr. Tauber is Plant Physician, Aliquippa Division, Jones & Laughlin Steel Corporation.

juries of the hand. To determine whether this ratio was typical we subsequently analyzed the injury experience for the first six months of 1957 and found that hand injuries comprised 47% of all injuries. This sort of information was available in the first 12 of the published reports cited at the end of this article,[1-12] in which the ratios of hand injuries were said to range from 32% to 73% of all injuries. In six of these reports, the ratios reported ranged from 40% to 50%. The ratio of 45% in the present study, then, may be considered to be representative for hand injuries in an industry with a high frequency rate of injuries of all kinds.

The present study is based essentially upon the data of the first 1,500 consecutively discharged cases of hand injury in the early months of 1956. This series may be considered representative of the hand injuries that occur today in plants such as the one under study. It turned out that most of these cases were of a minor nature only. To increase the statistical confidence with respect to more serious injuries, use was made of the records of all hospitalized hand cases for the six month period from which the study sample was drawn; and to get useful information on cases of such severity as to require hand amputation it was necessary to review the experience of 25 years. These latter two categories, however, represent only a minor portion of the present report, which deals essentially with a description of the 1,500 consecutively discharged cases.

Cause of Injuries

The accidents causing the hand injuries are reported here according to the statements of patients at the time of their first dispensary visits. For the purpose of this study the patients' histories were accepted as factual. Thus, if a patient stated he did not know the cause of an injury, this was accepted without comment. Based on these first statements by patients, the causes of accidents are listed in Table I, which shows that two-thirds of all hand injuries in the study resulted from five types of accidents: handling objects, mishaps with tools, striking hands against fixed objects, burns, and blows from moving objects. The first three of these causes account for 50% of the hand injuries studied. Data of this kind should be useful for the direction of prevention efforts by industrial safety officers, since they show the areas in which concentrated efforts are most likely to be rewarding. This point is given support by a closer analysis of injuries sustained during the handling of tools. Of the 175 cases with this cause, 45, or 3% of the total, occurred when "the wrench slipped." Such measures as routine tool inspection and on-the-job training in the use of tools suggest themselves at once as probably useful plant safety activities.

Table I—Types of Accidents

Cause of Accident	Number of Cases
Handling objects	419
Handling hand tools	170
Striking hand against objects	167
Burns	145
Struck by moving objects	105
Fixed machines	45
Twist, strain, or repetitive motion	29
Fall of employee	25
Skin irritation (dermatitis)	3
Vehicles	2
Other, miscellaneous causes	246
Cause unknown	144
Total	1,500

Table II—Frequency of Involvement of Parts

Part of Hand Involved	Frequency of Involvement, %
Right index	10.40
Left index	9.00
Right thumb	8.80
Right middle finger	7.86
Left thumb	7.73
Right little finger	5.06
Left middle finger	5.00
Right ring finger	4.93
Dorsum of right hand	4.46
Left ring finger	4.00
Left little finger	3.80
Right wrist	3.60
Left palm	3.33
Right palm	3.06
Dorsum of left hand	2.89
Left wrist	2.46
Combinations of above	about 13.62
Total	100.00

Nature of Injuries

The relative frequencies with which the different parts of the hand were involved are shown in Table II. Approximately 70% of the cases involved the fingers alone, and fingers were involved in combination injuries that comprised an additional 13% of the total. The index fingers were the leading injury sites, followed by thumbs. The ratio of right hand involvement to left was about 5:4. This corresponds closely with the ratio reported by Toland and Kornbluch,[12] whereas Simon[13] reported that in the garment and hat industries injuries to the left hand prevail. The parts of the hand involved in the accidents analyzed by Simon also differed from those in the present study.

The types of injuries in the present series are shown in Table III, arranged according to frequency of occurrence. Lacerations were by far the most frequently occurring type, accounting for 37% of the total. Abrasions were next in order, comprising 16% of the total. Other types, in descending order, were burns, embedded foreign bodies, contusions, puncture wounds, strains, sprains, and blisters. Fractures were a decidedly unimportant item numerically, accounting for less than 2% of the total.

Severity of Injuries

There was no convenient way to grade severity of injury in a numerical system that would have equally good meaning for all types of injury. Resort was had, therefore, to indirect indicators of severity on the basis of level of professional care required, number of treatments administered per case, the type of therapeutic procedure employed, and the degree of disability that resulted. By any and all of these yardsticks, the vast majority of the 1500 cases in the study must be considered minor injuries.

Nurses alone treated some 87% of the injuries. They referred the remaining 13% of cases to the plant physicians, who, in turn, referred less than 10% of these, or 1% of the total, to outside consultants. Cases so referred included occupational dermatoses as well as traumatic injuries. Because of the small number of patients hospitalized, the rate for this event was determined upon a larger experience base for the sake of increasing the representativeness of the value. Using for this purpose the patients with 2,769 hand injuries discharged during the first half of 1956 (from which the 1,500 consecutively discharged cases in the study were drawn), we found that only one hand injury case per 138 was sufficiently severe as to necessitate hospitalization. See Table IV.

Table III—Frequency of Types of Injuries, by Hand

Type of Injury	Right Hand, %	Left Hand, %	Both Hands in One Accident, %	Total, %
Laceration	21.13	15.53	0.20	36.86
Abrasion	8.60	7.40	0.26	16.26
Burn	5.33	4.13	0.33	9.79
Embedded foreign body	5.46	3.33	0.00	8.79
Contusion	4.00	4.26	0.00	8.26
Puncture wound	3.46	3.20	0.00	6.66
Strain or sprain	3.86	2.60	0.26	6.72
Infection of wound	1.63	0.66	0.00	2.29
Friction blister	0.80	1.13	0.06	1.99
Fracture of terminal tuft of distal phalanx only	0.13	0.26	0.00	0.39
All other fractures	0.47	0.60	0.06	1.13
Others	0.13	0.40	0.33	0.86
Totals	55.00	43.50	1.50	100.00

Table IV—Diagnoses of Twenty Hospitalized Cases

Diagnosis	Number of Cases
Compound fracture of a distal phalanx	2
Fracture of another phalanx	5
Fracture of a metacarpal	2
Traumatic amputation of soft tissue of tip of finger	3
Traumatic amputation of part of a bony distal phalanx	2
Traumatic amputation of 1½ or 2 phalanges of a finger	2
Lacerations of 3 fingers	1
Infected callus of finger	1
Small, benign tumor (fibroma)	2
Total	20

Table V—Dispensary Visits

Number of Dispensary Visits per Case	Number of Cases
1	224
2	505
3	353
4	173
5	85
6	44
7	29
8 to 37	87
Total	1,500

A total of 4,961 dispensary visits was made for treatment and observation of the hand injury cases in the study, about 3.3 visits per case. The cases are arranged according to the number of visits in Table V. About one-fifth, 224 cases, required a single visit. The more usual practice with regard to minor industrial injuries, in which follow-up observations are made to ascertain recovery, is reflected in the circumstance that two to four dispensary visits per case were made for 1,031, or two-thirds, of the injuries in the study. About 5% of the cases in the series required eight or more dispensary visits.

Conservative treatment, comprising essentially injury appraisal followed when needed by dressing, sufficed in 1,325 of the cases in the series; embedded foreign body removal was required in 139 cases; and definitive surgical procedures, ranging from lacerations repaired at a plant dispensary to major procedures at a hospital, were required in 36 cases. Lacerations were for the most part minor and superficial. Of 553 such injuries, only 21 (less than 4%) required suturing, 19 of them being accomplished in the plant. In one case a small fibrous

mass developed in the tip of a finger following contusion, and this was excised. Of a total of 22 fractures, 6 involved only terminal phalangeal tufts; and one-half of the remaining 16 required either a splint or a cast.

Roentgenograms were made in 80 cases to discover possible fractures (70 cases) or embedded foreign bodies (10 cases). As suggested above, the suspicion of fracture was confirmed in 22 of 70 cases. This diagnostic yield level suggests that the use of roentgenography in 5% of all hand injury cases was not an overuse of the procedure.

Antibiotic therapy, limited to penicillin by oral or subcutaneous administration, was used in the treatment of 13 cases in this series. Seven of these presented signs of localized infection, one being a case of infected callus of a finger which required conservative treatment in a hospital. In the six other instances, antibiotics were used prophylactically because of soiled lacerations or the presence of deeply embedded or multiple foreign bodies. In no case were incision and drainage required.

The physical therapy measures used were those available at the plant and administered by the staff nurses: moist heat, diathermy, ultrasonic radiation, and whirlpool baths. The usual indications for the use of physical therapy were persistent pain, swelling, and limited motion. A formal program of physical medicine has since become available as part of a rehabilitation program. We have come to believe, as a result of the experience gained in the new program, that such measures considerably reduce the disabilities we had come to expect for two kinds of fractures: those involving metacarpals, with perceptible angulation of fragments; and those involving first and second phalanges at locations near metacarpophalangeal and first interphalangeal joints.

From the 1,500 cases in the study series, 16 patients (or 1%) were assigned to limited work for varying periods that totaled 462 days for all such cases. The extremes varied from 3 to 108 days, the latter resulting from a case of dermatosis of both hands. The durations of limited work were distributed among the 16 cases as follows:

Less than one week	3 cases
Eight days	2 cases
10 to 20 days	4 cases
20 to 30 days	2 cases
30 to 69 days	4 cases
108 days	1 case

The diagnoses made of these 16 cases are summarized as follows:

Fracture	7 cases
Strain or contusion	4 cases
Laceration	3 cases
Dermatosis	1 case
Chemical burn	1 case

The seven patients with fractures on this list were assigned to limited work for varying periods, as follows: 4, 11, 25, 28, 51, 58, and 69 days, respectively. The last two of these cases were fractures of metacarpals, in each of which temporary total disability of five days each preceded the long periods of limited work assignment.

Temporary total disability was experienced in five cases in the study series for periods ranging from 1 to 59 days. As shown in Table VI, the injuries in four of these were fractures and in one an infected callus. The longest period of temporary total disability, 59 days, was associated with a case of compound fracture of the distal phalanx of the right thumb treated with a pin. The patient with this injury was able to return to his regular work at once following the long period of temporary total disability; but two other patients in the group of five had protracted limited work assignments, 58 and 59 days respectively.

Table VI—Injuries Resulting in, and Duration of Temporary Total Disability

Number of Cases	Duration of Total Disability, Days	Injury
1	1	Comminuted fracture, distal phalanx, right thumb
2	5	Fracture of right 4th metacarpal, and fracture of right 5th metacarpal, respectively
1	6	Infected callus left ring finger
1	59	Compound fracture distal phalanx, right thumb with pin
Total 5		

Permanent disability rating resulted in 6 cases in the study series, summarized as follows:

Loss of ½ distal phalanx, right thumb	2 cases
Loss of 1½ and 2 phalanges of middle fingers, respectively	2 cases
Limited motion, distal joint of thumb	1 case
Limited motion, left ring and middle fingers	1 case

An accurate estimation of time lost from work in connection with the 1,500 cases in the study series must include the time required to make the 4,961 dispensary visits for treatment and observation. In our large plant, despite the convenient locations of four dispensaries, an average of 45 minutes' absence from work is required for medical services of the kind under consideration here. These 4,961 dispensary visits total 3,720 hours, or 465 man-days lost as a result of the injuries sustained. This

figure is approximately equaled by the total number of days of limited work assignment required in the management of 16 of the cases. Together, they constitute a hidden or concealed time loss that dwarfs the 76 days of temporary total disability experienced by five of the most severely injured employees.

Extensive mutilating hand injuries, fortunately, seem to occur only rarely in the steel plants of today. No such injury occurred in the present study series of cases. Indeed, records had to be searched for several past years to find such cases. At the plant under study, five major hand injuries resulting in full hand amputation have occurred in the past 25 years: one in each of the years 1933, 1937, 1938, 1940, and 1947.

Personal Factors

A study of this kind obviously ought to give consideration to the personal characteristics of the employees who were injured. Such information is not routinely produced at the plant dispensaries at which these cases were treated, at least not in a way as to be useful in the present report. We are limited, instead, to estimations of the possible influence upon the likelihood of injury of such factors as sex, age, years of experience, and fatigue. In addition, an early observation that injury of both hands in a single accident might be an indicator of accident proneness resulted in the focusing of close attention upon employees with such experiences.

At the plant under study women are employed as production workers only in the tin plate department. For the duration of the study, 4½ months, women in this department sustained hand injuries at the rate of 10 per 100 employees, whereas men sustained such injuries at a rate of 25 per 100 employees. Virtually all of the women employed in the department work as assorters, in which job there is repetitious handling and flipping of tin sheets, while men as a rule do not perform these jobs. Because of the noncomparability of the jobs, and hence, the risk of hand injury, we really have no data upon which to make a judgment upon the possible influence of sex difference as a factor in the causation of occupational hand injury.

The possible influence of age upon the occurrence of injuries in the study was considered with respect to male employees only. Injury rates were computed for the age groups 18-25, 26-35, 46-55, 56-65, and over 65 years. The highest frequency rate appeared in the 18-25 year group which although comprising only 13% of male employees experienced 20% of the hand injuries. The lowest rate occurred in the age group 56-65 years, although this was not significantly lower than the rate among males whose ages exceeded 65 years. Our present assumption is that the highest rate in the youngest age group results from a relative lack of experience among new employees. One might hypothesize with equal confidence that the difference in rates results from assignment of younger men to jobs with high risks of hand injury. It would be impossible to test this hypothesis directly from presently available records, since the job descriptions at the plant do not reflect this aspect of a job.

That the nature of jobs predominantly influences the likelihood of hand injury is suggested by the observation in this study that certain departments of the plant consistently experienced greater frequency rates for this type of injury than did other departments. For the four and one-half month period of the study, the lowest rate occurred in a department in which 29% of the persons at risk sustained hand injuries. In increasing order the rates were from 30-39% in five departments, from 40-49% in five departments, from 50-59% in three departments, and about 70% in one department.

The influence of fatigue upon the occurrence of hand injuries was studied from the standpoint of when injuries occurred with respect to shift, hour of shift, and day of the week. The shift plan in effect at the plant is that which is common for the industry: rotation through all shifts, and gradual progression of the work week through all days of the calendar week. The first day of the work week thus rarely corresponds with the first day of the calendar week. We nevertheless examined the injury experience on a calendar week basis, to ascertain what influence the calendar pattern in the workers' home life might have upon the injury experience at the plant.

Hand injuries occurred during the three work shifts in approximate accordance with the proportion of the work force employed on each shift. The actual numbers of cases on each shift were as follows:

12-8 shift	309 cases
8-4 shift	742 cases
4-12 shift	415 cases
No record	34 cases
	1,500 cases

The work shifts were divided in quarter shifts of two hours each, and the quarters in which injuries occurred were determined to be as follows:

First quarter shift	395 cases
Second quarter shift	440 cases
Third quarter shift	313 cases
Fourth quarter shift	278 cases
Unrecorded	74 cases
	1,500 cases

Table VII—Occurrence of Injuries of All Types during Corresponding Six Months of Two Successive Years, by Days of the Week

Day of Week	1959	1957	Total
Monday	948	857	1,806
Tuesday	944	892	1,836
Wednesday	1,026	862	1,888
Thursday	978	910	1,888
Friday	1,019	875	1,894
Saturday	707	558	1,268
Sunday	510	391	901
Total	6,132	5,345	11,477

Table VIII—Three Departments with Highest Hand Injury Rates: Correlations Among Frequency Rates, Repeat Injuries, and Hiring Rate

	Order of Department among Fifteen Departments		
	Rod & Wire	Tin Plate	Welded Tube
Incidence of hand injuries during first six months of 1956	1	2	3
Incidence of hand injuries during the study period	1	2	3
Hiring rate during first six months of 1956	4	2	3
Rate of hand injuries in department among the 1,500 cases of the study	1	2	3

The occurrence of the lowest number of cases in the final two hours of the work shift suggests that fatigue, insofar as it can be measured by this indicator, was not an important factor in the cause of the injuries studied. Overtime work was briefly considered as another possible indicator of fatigue, but the consideration was rejected on the basis that overtime activities outside the plant could not be segregated from those inside. It is well known, for instance, that many of our employees have second jobs, which may precede or follow a shift of work at the steel plant. An additional number are self-employed in small enterprises which are even more demanding than their respective mill jobs. Other nonquantifiable contributors to fatigue are late entertainment and family illnesses. All in all, then, we are unable to show any correlation between fatigue and injuries studied.

The numbers of cases of hand injuries on different days of the week during the study period sufficiently paralleled the numbers of persons working as to support a conclusion that outside-plant activities on week ends had no influence upon the rate of occurrence of hand injuries in the plant. To see whether this conclusion might be applicable to all occupational injuries we summarized the total injury experiences for the first six months of 1956 and the first six months of 1957. These summaries are shown in Table VII, and they add support to the conclusion that Monday is not a particularly bad day of the week with respect to industrial injury frequencies.

Students of accidental injuries are usually interested in accident repeaters. There were 245 such repeaters in the present study group of 1,169 employees. The repeaters, who comprised 21% of the population at risk, had 38% of the 1,500 injuries in the series. The three departments which experienced the highest frequency rates of hand injuries had also the highest ratios of repeaters. To shed some light on the relative importance of personal factors and types of work to injury repetition, we compared the hiring rates (labor turnover) with the relative injury rates of the three departments for the first half of 1956 as well as for the more limited study period. This comparison is presented in Table VIII, and shows a good correlation among the chosen variables. This suggests that such personal factors as find expression in labor turnover are at least partly responsible for repetition of injuries in this particular population.

Our attention was drawn early in the study to cases of injury of both hands in a single accident. There were 20 such cases, all among men. The diagnoses made in these cases are summarized as follows:

Burns, thermal or chemical	5
Abrasions, bilateral	4
Strain	4
Laceration	3
Contusion	1
Blister	1
Mixed injuries	2
Total	20

A large proportion, namely 10 of the patients (50%), were treated during the brief period of our study for additional injuries: four had one each, four had two, one had three, and one had four. Eleven of these twenty persons belonged to the 18-25 age group, five to the 26-35 age group, three to the 36-45 age group, and one was 51 years old. These observations support a recommendation that close attention be given to a man who injures both hands in a single industrial accident, as well as a tentative conclusion that double hand injuries are most liable to occur among the youngest and least experienced employees.

Summary and Conclusions

This report deals with 1,500 occupational injuries of the hand, wrist, and fingers among persons employed at a large, integrated steel plant. These injuries, referred to by the general term hand injuries, comprised about 45%

of all injuries that occurred during the period of study.

The vast majority of the hand injuries were of a minor nature. Roughly 90% of the series were treated by plant nurses alone, and 10% were referred by the nurses to plant physicians. Nine-tenths of these were treated by plant physicians, and the final 1% of the total cases were referred to surgeons outside the plant.

Significant infections occurred rarely in this series of cases. Antibiotic treatment, limited to penicillin administered orally or subcutaneously, was used in only 13 of the 1,500 cases studied.

An analysis of records for indicators of possible relationships of personal characteristics to accident causes revealed a substantial increase in the frequency of repeaters among those persons who sustained injuries of both hands in a single accident. A second observation along this line was that departments with the highest labor turnover also have the highest injury rates.

An analysis of temporary total disability and of limited work cases revealed that these outcomes are apt to occur with certain simple fractures of metacarpal bones and phalanges. Formal, aggressive programs of physical therapy and rehabilitation should be instituted early in the treatment of such injuries.

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Certification in Occupational Medicine

—*A PANEL DISCUSSION*—

I. Backgrounds and Policies Involved in Certification

Robert A. Kehoe, M.D., Cincinnati

THE TITLE of this portion of today's discussion might seem to carry the implication that certification in occupational medicine is something new and different in the field of certification in American medicine. Actually all that is new about it is the inclusion of occupational medicine among the recognized specialties. It is precisely this point which I wish to emphasize—namely, that the means whereby a special field of medical practice in the United States and Canada comes into existence, brings itself into recognition in medical circles as a body of special knowledge and skill, and then gains official recognition as a specialty, has been well established for many years. In order to achieve such formal status, occupational medicine had to fit itself into the pattern so established.

As early as 1941, the American Board of Industrial Medicine and Surgery was formed by leaders in the forerunner of the Industrial Medical Association (The American Association of Industrial Physicians and Surgeons), for the purpose of achieving official recognition of what, in their minds and those of their associates, had become a special field of professional practice. In 1943 representatives of this Board appealed to the Advisory Board for the Medical Specialties for official recognition. This appeal was unproductive, and, although the attempt was made, later, to revive the issue, it remained moribund for seven additional years. At this time, when events have moved forward, certain issues have been clarified, and the field of occupational medicine, itself, can better be visualized, the essential reasons for the official disapproval of the establishment of a certifying board in industrial medicine and surgery can be both understood and accepted. It is necessary to visualize the trends in medical practice and in medical education in North America, if the situation is to be viewed in its proper perspective.

Specialization in medicine and surgery and in certain specific fields of medicine and surgery had proceeded at a rapid pace—indeed at such a pace that the question was being raised, seriously, whether the specialties were not too numerous and too narrowly restricted. The training of every specialist, meanwhile, had come to be more and more exacting in time and scope.

In contrast, the claim set forth, that the physician in industry was a specialist, was based not upon restriction of his technical field but upon its locale. Surgeons, dermatologists, general practitioners of medicine—all of these and others—were in this field of practice, their only common feature being that their patients were men and women employed in industry. The situation which confronted those concerned with the specialty boards and with the accreditation of the training of specialists was utterly unique and out of character. I believe it fair to say that at that time it was not possible to define industrial medicine—or industrial medicine and surgery, as the field was known—in any terms that had a common or specialized ground of professional performance. Since there was no means of resolving these issues or of reaching any acceptable conclusion, the matter remained at rest; time and change were required to set it in motion.

By 1950 the scene had altered. Not only had physicians in increasing numbers gone into practice within industrial medical organizations, but the form of medical practice in indus-

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try had altered, first a little and then more rapidly, in response to the growing need, until the importance of industrial hygiene, as a combination of environmental engineering and preventive medicine, had come more and more to be appreciated. Moreover, the formal training of industrial physicians had been undertaken in several centers of medical education, with the result that the professional armamentarium of the practitioner of industrial medicine had been forged. It had not been shaped in final incisive lines, but it existed as a tangible structure that could be examined and understood. The time appeared to be ripe for a new effort for the achievement of specialty status. It is not entirely irrelevant that the terms "industrial medicine and surgery" and subsequently "industrial medicine," as the one-time proposed names of the putative specialty, had been superseded, almost spontaneously, by that of "occupational medicine," with its wider meaning and, one may hope, its broader view of the future. As an expression of these developments, the Interim Board of Occupational Medicine came into existence, composed of representatives of the American Association of Industrial Physicians and Surgeons, the Section on Preventive and Industrial Medicine and Public Health of the American Medical Association, and the American Association of Occupational Medicine.

The history of the steps taken from the formation of the initial American Board of Industrial Physicians and Surgeons in 1941 to the dissolution of the Interim Board of Occupational Medicine in 1955 has been recounted in *Industrial Medicine and Surgery* (25:25, 1956) by Sterner and need not be repeated here. The substance of the matter, for present purposes, from 1951 on may be stated briefly in general terms.

1. The official approval of the Advisory Board for the Medical Specialties had to be obtained for the establishment of any certifying board.

2. On the recommendation of this Advisory Board, the Council on Medical Education and Hospitals of the American Medical Association could consider the application of the Interim Board of Occupational Medicine for authority to establish a Specialty Board.

3. The requirements imposed by the Council on Medical Education and Hospitals upon any such representative applicant are, essentially, that the field of specialization be defined in clear and definitive terms that will differentiate the field of the specialty from any and all others, and that there be in existence, or in realizable potential, a prescribed regimen of professional training, specific and adequate in its subject matter and definite with respect to the period of time required for its completion.

Out of the discussions of the Interim Board of Occupational Medicine with the Advisory Board for the Medical Specialties and the Council on Medical Education and Hospitals and with the Liaison Committee of these two official bodies, which took place as the schedules of official meetings permitted from time to time from 1951 through 1953, it came to be apparent, first, that a separate and independent Board of Occupational Medicine could not be established soon and that occupational medicine must seek in good faith, and if possible find, an affiliation within one of the existing specialty boards, if it was to gain the status of a certifying agency without further and perhaps prolonged, even indefinite, delay; second, that the basic requirements of the Council on Medical Education and Hospitals and the Advisory Board for the Medical Specialties, as applied across the field to other certifying boards, would have to be met in full. The latter requirements, in principle, for the professional and administrative action of any such Board, included such provisions as the following: (1) that certified specialists must be engaged exclusively in the practice of the specialty as defined officially; (2) that those admitted to certification without examination must fulfill certain stated and generally accepted qualifications, and that, in addition, they must be limited in numbers, in proportion to the total number of initial applicants, to a conventionally acceptable fraction, of the approximate order of a fifth, or at most a fourth, in accordance with criteria devised to achieve such a separation of the Founders' Group from those who would be required to take an examination; (3) that a type or regimen of examination be established which, in an effective and realistic manner, would put to the test the qualifications of the applicants, to the end that only fully qualified specialists would achieve certification.

In seeking out a suitable niche within the existing specialty boards, in which an affiliation could be established, the Interim Board of Occupational Medicine found welcome in the American Board of Preventive Medicine and Public Health. The members of this Board, which had been formed officially in 1949 and had only recently accepted aviation medicine into an equality of affiliation, manifested a willingness to negotiate with the Interim Board, and, in the conferences which followed, showed themselves to be fully capable of adapting their procedures and policies in matters which seemed imperative to members of the Interim Board if

they were to achieve an equality of representation within the American Board of Preventive Medicine and Public Health and a reasonable amount of freedom for the development of their specialty. An agreement with this group, which had changed its original name to that of the American Board of Preventive Medicine, was reached in 1954, and official sanction was given to this agreement by the Advisory Board for the Medical Specialties and the Council on Medical Education and Hospitals in February, 1955.

Now, of course, came the test, for the selection of a Founders' Group and the adaptation of the existing mechanisms of the American Board of Preventive Medicine in the matter of examinations to the needs and susceptibilities of specialists in the field of Occupational Medicine, and especially the difficulties of intraprofessional communication, could not fail to be to many, if not the majority, of industrial physicians a painful and disillusioning process. This has been the case, it seems, in every previous professional experience of this type. It is not possible to please everyone, and it was utterly impossible to include within the Founders' Group all of those who had pioneered in, or had made significant contributions to, industrial medicine. Moreover, the formulation of policies and the making of decisions has always a certain aspect of arbitrariness in that these must, in the final analysis, be based upon personal judgments, the correctness of which can only be tested by time.

The establishment of a specialty board involves the appraisal of a type of medical practice in terms of its present scope, but it has to do with much more than this. It concerns itself with the future of medical practice in a specific field, with what is to be undertaken and what is to be achieved. These concerns find their principal outlet in the efforts of the board to foster satisfactory graduate education in the specialty, to advance its professional standards, to visualize its scope in relation to medical practice generally, and to improve the performance of the individual and of the group as a whole within the field. Professional training creates the future specialist, and only if such training is sound in quality and in keeping with the developing needs of society can it be right. Here, we believe, is the principal, almost the entire, point of the effort. The Founders' Group is but the initial symbol, the masthead, and the professional backing of the Board. It should not be thought of in terms of the prestige of the individual, but rather as the best possible representation of the professional standing of the group and of the field represented by the board. The board, if it is honest, faces the future with its responsibilities full upon it and undertakes to represent, but also to guide, the specialty toward the fulfillment of its highest professional purpose. By its examinations it selects the specialists of the future, and, by its emphasis on training, it shapes those from whom the selection is to be made. As we view this in our time, our concern should be to understand our field of professional practice, to be equipped with its knowledge and its armamentarium, and to extend its scope and its influence by the quality of our practice, by the applicability of our research to its major problems, and by the scope and excellence of the training which we offer, through our wisdom and experience, to those who are to come after us.

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II. Nature and Objectives of the Specialty

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THE TERM "occupational medicine" means many things to many people, both within and outside the medical profession. This is understandable when one considers the evolution of this relatively new branch of medical practice. The transition from the simple and direct beginning, when the sole relationship of medicine and industry was one of caring for the injured workman, to the complex structure of many of our present-day industrial health programs, has been the result of a series of modifications and innovations by medicine to meet new and changing needs of our increasingly industrialized society.

In the present organization of occupational medical services there has developed a variety of patterns—of combinations of the elements identified with the practice of occupational medicine. It is common to find, in the same community, a wide gradation of these programs, with each stage of development identified as "occupational medicine."

It must be emphasized, again and again, that the basic values of the particular services—to

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society or to the practitioners themselves—are not in question, nor are they the significant determinant in the matter of qualifying as a specialty.

For an analogy, we need only to cite the relationship of general practice to one of the accepted medical specialties such as urology or psychiatry. No one can properly say that the one service is more valuable than the other. One may question the validity of the whole specialty structure, or of the general criteria which have been applied in distinguishing a specialty, but if so, this is a larger consideration than we can deal with here. We must recognize, too, that frequently the concern or contention with the problem of specialty status has involved such elements as economics or prestige and not the standards which have become accepted for defining a specialty.

The initial service of medicine to industry was in the care of the occupationally injured individual. It is not likely that the physician who treated an occasional case of occupational injury considered himself an "industrial physician." As the proportion of such cases increased, however, the surgeon began to identify himself with the source of his practice, and industrial surgery gained some recognition as an entity. With the advent of workmen's compensation, and the increasing size of industrial establishments, problems arose in the management of cases of occupational injury which were more effectively handled by the physicians with skill and experience in these matters. In the larger plants, with a sufficient volume of traumatic cases, the chief surgeon, often on a full-time basis, emerged as the principal medical officer. To care for the injured workmen from smaller industrial units, the industrial medical clinic developed, with its primary function the treatment of occupational injuries. Many such clinics continue to function in this manner and provide an invaluable service to the community. However, the line was never clearly drawn on a surgical basis between the management of cases of trauma from industrial injuries and those arising from other sources.

Occupational disease, as distinguished from traumatic injury, was identified many centuries ago. The full significance had to await the industrial revolution, improvements in the science of medicine, and changes in sociologic attitudes and conscience. The initial role of the physician was that of diagnosis and treatment, but very few of the doctors managing these cases considered themselves "industrial physicians." The identity with occupational medicine was acquired chiefly by those physicians who pursued the problem into the industry, primarily with the purpose of identifying the specific cause and preventing further injury.

As the size of industrial units increased, and as technological operations became more complex and hazardous, the locus of the physician serving industry began to move from the private office, clinic, or community hospital into the plant. Initially, in most industrial plants, a major portion of the efforts of the in-plant physician was concerned with the care of injured employees, and as such, the nature of his practice had little to distinguish it from that of the physician serving industry from his private office. As safety programs developed and as selective placement of workers was started and became more effective, the number of traumatic cases diminished, and with this, the proportion of the in-plant physician's time devoted to the treatment of occupational injuries.

The physician in industry, with his availability and more direct interest, became increasingly concerned with the industrial environment. He played an active and important role in safety programs. As quantities and varieties of hazardous chemical and physical agents were introduced, he developed a specialized skill, knowledge, and experience in evaluating the hazard, and, as a member of the industrial health team, in providing a safe and healthful place to work. Again, the tremendous contribution of the physician serving industry from private practice must be recognized, but increasingly the major developments in occupational medicine came from the physician employed full-time in industry or in governmental or university activities directly related to occupational health. Admittedly, his greater role was due in part to the better opportunity which his full-time position afforded, but there occurred a significant change in his orientation, with an emphasis on prevention.

Superimposed on these basic functions, involving treatment—the care of the occupationally injured workman—and prevention—the control of the industrial environment—are a host of activities, many of which have little direct counterpart in the traditional practice of medicine but which serve further to distinguish the increasingly specialized character of the practice. Of significance, is the change in emphasis, from treatment to prevention. Prompt and effective treatment must be provided when an injury occurs. But the very occurrence of such an injury has come to be viewed as an admission of failure in the prevention-centered program, and the effort which is devoted to preventing further occurrence of such injury has developed, in the concept of many, as a distinguishing characteristic of occupational medicine.

With selective placement initiated to assure that the employee could *safely* perform the assigned work, it was an easy step to the recognition that the examination might aid in determining whether he could do the job effectively. Thus, selective placement added new dimensions, and the medical program became an integral factor in the effective operation of the industry.

With the recognition of the significance of cost of absent employees, the problems of personal illness developed new meaning. The direct effect on production, the increasing expenditures for sickness allowance, and a growing genuine concern for human values, have created a valid and proper interest on the part of industry in the general health of its people. With the need for advice and counsel with respect to health problems, for the contribution which a physician could make in the planning and administration of employee benefit programs, for understanding and guidance in controlling sickness absence, it was reasonable for industry to turn to the physician in whom it had confidence, and who was more likely to understand its problems. Thus, the occupational physician further expanded his activities to encompass functions which could not be as easily or efficiently managed from a private practice relationship.

Another distinguishing feature in the emergence of this specialized service is the interest in group relationships, as contrasted to the traditional individual doctor-patient relation of private practice. An understanding of and ability to deal with sociologic motivations, as well as individual psychologic factors, acquired a new significance. The evaluation of group phenomena demanded a facility with statistical procedures. Epidemiologic considerations took on a new meaning where a responsibility for a whole population was involved. The control of infectious or degenerative disease for the group required new approaches and methods.

A number of other functions have developed to meet the ever-broadening interests and relationships voluntarily acquired by and sometimes imposed upon industry by changing technologic and sociologic influences. In the area of environmental controls, information of value in protecting the employee against a hazardous industrial chemical frequently is needed by the customer who buys and uses this chemical. Thus, the industrial hygiene function becomes involved in product development and control. A hazardous gas, vapor, or dust is exhausted from the work area in a plant and discharged into the atmosphere of the community. Thus, air and water pollution control becomes inseparable in many aspects from industrial hygiene. The interests of an industry become inextricably bound with those of the community in which it exists, and the services of hospitals, voluntary health agencies, and governmental health units are at once a source of invaluable help, a mechanism requiring financial support, and a potential security threat if medicolegal requirements are not met. To secure the maximum values for his people, to obtain a reasonable economic return for his industry donor, and to avoid infringement upon legal requirements, the practitioner of occupational medicine must understand what services are available, how much his organization should and can contribute, and what is needed to comply with ethical and legal codes.

There are many more areas of interest and legitimate activity for this expanding concept of the practice of occupational medicine which cannot be developed in this brief presentation. It seems inevitable that these valid interests should extend beyond the present accepted area of occupational health programs, into such matters as programs of medical care for industrial workers, since industry and labor are already so deeply involved. The distinction between the scope, objectives, and functions of occupational health programs, so well defined in the American Medical Association statement, and other activities involving industry, labor, and medicine should be clearly recognized. This does not mean, however, that the physician practicing occupational medicine is excluded from participation in these matters. If he devotes a major part of his activities to product development, or to general medical care programs, it may well be that he is no longer practicing occupational medicine, and hence does not qualify for recognition in this field of specialization. Similarly, the individual whose practice has not developed the additional functions which have become accepted as differentiating the specialty of occupational medicine cannot qualify as a specialist until he has met the officially recognized requirements.

In the practice of occupational medicine, as in the case of the other specialties, there is no absolute point, no unanimously accepted line in the continuum of increasingly specialized functions, which marks the boundary between specialty and nonspecialty. The earlier attempts to gain recognition for a practice combining the care of injured workmen with a varying effort in controlling the industrial environment failed because this degree of definition did not satisfy the standards established for a specialty. Only as the emphasis on preventive functions developed was there a recognition that occupational medicine was becoming sufficiently distinguished

from other forms of medical practice to justify a qualification as a "specialty."

We can be sure that many of our concepts and interpretations will change as new needs develop for adapting medical service to industry and society. We can only hope that our action in accepting the responsibility of specialty status for occupational medicine will promote the highest ideals, the greatest effort, and the most effective organization of service for advancing the health of our working men and women.

Dr. Sterner's address is Eastman Kodak Company, Rochester 4, N.Y.

III. Qualifications of the Certified Specialist

A. G. Kammer, M.D., Pittsburgh

ONE WORKING definition of occupational medicine is that it is the medical component of a broad professional field called occupational health.

Occupational health may, in turn, be defined as the total professional activity that concerns itself with the interrelationships of health and the circumstances of working for a living. There are three kinds of such relationships: those in which a factor of work is the cause of a health problem or a disability; those in which a factor of work aggravates a previously existing problem; and, finally, those in which work or some factor of work produces the opposite effect, namely, results in an improvement of the health level. The first two of these, cause and aggravation, are identified with the disability for which workmen's compensation benefits are paid. The third, that of improving health by working, is a relationship which was first exploited in a formal way by our colleagues in the new rehabilitation programs.

Every practicing physician in industry worth his salt has known all along that there is an optimum time for returning the injured worker to his job, and that frequently this optimum time precedes full recovery by a considerable period. But the formalization of practice around this concept and its extension to the nonoccupational disability area were developments of a closely related field, not strictly our own. The factors of employment which favor achievement of the individual's full potential for physical and mental health need to be discovered through research in the fields of work physiology and psychology. Once a logically ordered body of knowledge of this kind is at hand, the specialist in occupational medicine may be expected to emphasize the kind of work his patient needs and to be less concerned with the kind of work he should not do. On that future day our special form of practice will become essentially positive and constructive, and only secondarily defensive and negative.

Dr. Kammer is Professor and Head of the Department of Occupational Health, University of Pittsburgh.

It turns out, then, that work activities and health are intimately interrelated; and in the dynamism usually present in either area this interaction is constant, varies in importance and intensity, and may be either negative or positive. The professional field of occupational health must therefore seek to bridge two of the most complicated technologies thus far devised by man: modern industry and modern health science. It claims a capacity to recognize problems which have their origin or cure in one area and their cure or origin in the other. This is no modest claim. To make good on it requires professionals of unusual competence.

It follows that the physician who practices competently in this field does not simply practice traditional clinical medicine in a different place, say within the confines of a plant; he also practices a special kind of medicine. To prepare himself for this practice he must learn to use in a new way that which he has already learned in his previous medical training, and must add considerably more to this body of knowledge.

The formal training programs which have received full approval by the American Medical Association's Council on Medical Education and Hospitals are located at Cincinnati, Pittsburgh, Rochester, Ohio State, and Yale universities.

Formal training is accomplished over a three-year period of study, two of which are spent at the university, and a third at a field facility which has been approved for this purpose. The studies are of three kinds: didactic courses, supervised work, and research. Some research training is considered essential for the reasons that the two bases of this special practice, industry and health science, are themselves areas of constant research and change. The successful practitioner must have capacities to read knowingly and to judge soundly the voluminous literature which can keep him abreast of the changes certain to occur in his lifetime. If we can make him a perennial student, the universities will have been successful.

The usual medical school graduate comes to us with a good understanding of the diseases

which have been their bases in the biological and social fields, but less well informed in those conditions which stem from physical agents; and as regards the physical sciences, themselves, we find the young physician on the average, to be seriously deficient. Our courses in industrial hygiene and health physics are therefore buttressed with considerable basic review material, as are the preclinical sciences of biochemistry and physiology as these apply to clinical toxicology and occupational medicine. Occupational medicine requires further reviews of selected portions of other clinical specialties as these impinge upon industrial health practice: cardiology, dermatology, roentgenology, some surgery, some psychiatry, and rehabilitation, to name the most important. An understanding of these is a prerequisite for competence in occupational placement, disability evaluation, and occupational disease management.

But a more important segment of industrial health practice has to do with prevention. Translated into industrial terms, this means the best possible understanding of the worker and the work place, manipulation of either or both to assure health and safety, and continuing observations upon both to determine whether things are going as planned. The meaningful indicator of trouble is frequently to be discovered only by appropriate studies of data developed from the work force as distinct from observations on a single patient. The techniques of statistics and epidemiology become necessary tools of the industrial practitioner, and his "patient" is sometimes a population, not an individual.

The administrative competence to accomplish all of this with an adequate staff within the supervisor-subordinate structure of industry and the political structure of the community is learned only in part from lectures on administrative theory at the university, and principally by precept and participation at the field training facility in the third year.

These, then, represent the apparently heterogeneous array of competences which the board examination in occupational medicine and preventive medicine seeks to test. We believe that the physician who possesses these competences and has learned how to use them in the unique situations offered by industrial practice will acquit himself well as a doctor of medicine, and will make a substantial contribution toward the solution of some of the really difficult problems of our times.

Dr. Kammer's address is Graduate School of Public Health, University of Pittsburgh, Pittsburgh 13.

Advance Announcement

THIRD ANNUAL

WESTERN INDUSTRIAL HEALTH CONFERENCE

will be held

October 2 and 3, 1959

at the

Statler Hilton Hotel, Los Angeles

Discussions at this meeting will concern health, safety, hygiene and compensation. Program details will be published at a later date. If further information is desired at this time, communicate with Esther Klingsheim, Assistant Secretary, Western Industrial Medical Association, AiResearch Manufacturing Co., 9851 Sepulveda Blvd., Los Angeles 15.

The Determination of Injury from the Internally Deposited Radioisotope Plutonium

W. Daggett Norwood, M.D., Richland, Washington

SPECULATION that very small doses of radiation may cause certain types of somatic damage, such as leukemia and life shortening, is sensational and has been given wide publicity. This makes it imperative to define radiation injury and to establish basic criteria for its diagnosis, if we are to avoid situations in which claims are made and possibly paid before there is evidence of injury. A recent report indicates that a claim for compensation has been made in the state of New York by a physicist for life-shortening which, he alleges, may result from occupational exposure to radiation incidental to cancer therapy studies.[1] The following discussion considers the problem of radiation injury, from a practical viewpoint, taking the radioisotope plutonium as an example. Present knowledge of plutonium toxicity is summarized to aid in deciding whether there is sufficient basis for predicting that radiation from a certain estimated deposit within the body will or will not cause damage.

Man lives in an environment in which he is continually exposed to radiation due to cosmic rays and to the presence of radioactive materials in the earth. The average annual natural exposure in this country is estimated to be about 100 millirems to the gonads and 130 millirems to the bone marrow.[2] Whether such exposure is deleterious to the individual or the race is a matter for speculation. Geneticists feel that at least an appreciable portion of present mutations are due to this natural exposure.[3] Whether this small natural exposure contributes to leukemia, life shortening, etc., is highly speculative at present.[4] Since this exposure cannot be avoided, it is considered normal. It is known that exposure of the whole body to high levels of penetrating radiation are definitely harmful. Between these two extremes there are levels of man-made radiation which are said to represent acceptable risks on the part of the individual concerned.

Dr. Norwood is Manager, Health and Safety Operation, Hanford Atomic Products Operation, operated by General Electric Company for the Atomic Energy Commission.

This article was read before the Annual Conference of Industrial Physicians, Hygienists and Health Physicists associated with the Atomic Energy Commission, Robert A. Taft Sanitary Engineering Center, Cincinnati, Oct. 29, 1958.

Injury Due to Plutonium (Pu^{239})

The National Committee on Radiation Protection and Measurements has set levels of permissible exposure to ionizing radiation that in the light of the best present knowledge are not expected to cause appreciable injury manifestable in the lifetime of the individual.[5] Let us consider the question, "At what point is an employee who has received internal deposition of plutonium at work to be considered as injured?" Is it when our best estimates indicate a deposition equal to, or 100 times, the maximum permissible deposit? Or is it when the best medical diagnostic criteria indicate that the employee has a recognizable disease, such a bone sarcoma, which has probably resulted from the deposition of plutonium which occurred many years earlier?

Precedent

To date there has been no recorded instance of injury to man due to the internal deposition of plutonium. It has been common knowledge for many years that radium dial workers who ingested small quantities of radium developed, years later, serious lesions of bone and of the hematopoietic system as a consequence. In such cases is has been considered that injury exists when there is demonstrable harmful effect present which has probably been caused

by the radium deposit within the body. The National Committee on Radiation Protection and Measurements defines harmful effect as "any body injury, disease, or impairment, except where such condition is transitory, infrequent, or of short duration, and does not endanger persons so affected."[6] Handbook 52[7] states: "Experience with man will give the only completely reliable data, and even here the statistical variation is so great that data should be obtained for a large number of cases in order to obtain reliable results. Because of the uncertainties involved in the present values and in determining the actual accumulation and potential hazard of radioisotopes in the human body, it is strongly recommended that exposure be kept at a minimum insofar as it is practicable." Unless it can be stated with some degree of certainty that a specific estimated deposition of plutonium in the human body will always cause nontransitory body injury, disease, or impairment, it does not seem justifiable to consider such a deposit to be medically damaging unless injury becomes evident. Let us consider the likelihood of being able to make such a prediction.

Maximum Permissible Plutonium in Body

How definite is our knowledge concerning the damaging effects of plutonium deposition in the human? We have no direct information on the pathologic effects of Pu^{239} deposition in man, since to our knowledge none have occurred. We infer that certain qualitative and quantitative dose and effect relationships will probably occur in man, since they occur in both laboratory animals and man with Ra^{226} and they occur with Pu^{239} in animals. We have some knowledge concerning the metabolism of Pu^{239} in man gained from studies in which small doses were injected intravenously and its deposition within the body and excretions from the body studied.[8] The maximum permissible deposit in the body is established largely by relating its effect to that of radium in man, since there is at least some similarity of their behavior in the body. This is modified by taking into account the difference in damage that equal quantities of absorbed energy from Ra^{226} and Pu^{239} causes in laboratory animals. Laboratory animals were used to test the damaging effects of radium only after it was discovered that man was suffering from poisoning by radium. Fortunately, in studying toxic effects of plutonium deposition, we are able to reverse this procedure. Effects of plutonium in laboratory animals are determined, and these are compared with the effects of radium in similar animals and in man. Unless actual damaging exposures to plutonium occur in man, we can only estimate what the effects may be by such indirect studies.

Toxicity of Pu^{239} Versus Ra^{226}

The relative probability of neoplastic and other changes being induced by internally deposited Ra^{226} and Pu^{239} will depend upon several factors as follows:[9]

A. Site of Injury—In general, specific injury is most probable in tissues in which the combination of concentration of the radioisotope and tissue sensitivity to the isotope is maximal.

1. (*a*) The location in the body of Pu^{239} depends upon its chemical state and mode of administration. Poorly soluble Pu^{239} which is deposited in the skin or flesh may cause a tumor in this location.[10] Poorly soluble Pu^{239} when inhaled causes a lung hazard until it is eliminated by ciliary action or transferred to bone or liver. Ingested Pu^{239} is very poorly absorbed. While as much as 25% of the body deposit of soluble Pu^{239} may be in the liver, studies to date indicate that the bone is the critical organ for material which has gained access to the circulation.

(*b*) Ra^{226} is largely deposited in bone but is concentrated in the crystalline lattice of the bone in a manner similar to calcium, while Pu^{239} is concentrated on bony surfaces—endosteal, periosteal, and vascular channels.[11] Pu^{239} is therefore much closer to the blood-forming elements than is Ra^{226}. A radium daughter, radon, is eliminated via the respiratory tract.[12] Chemically, Ra^{226} is much like calcium in its deposition and release from crystalline bone, while the metabolism of Pu^{239} is quite different. Excretion of radium in humans takes place largely by way of the bowel, while excretion of plutonium in humans is divided fairly equally between the urine and the feces. The fraction going from the gastrointestinal tract to blood[7] is about 0.2 for Ra^{226} while it is only 0.00014 for soluble Pu^{239}.

B. Type of Radiation—While both elements emit alpha particles, Ra^{226} plus its daughters has beta and gamma emanations as well. Pu^{239} also has a small component of weak x-ray energy (17kv). Mesothorium (MsTh) was often associated with Ra^{226} in the most thoroughly studied cases. Being an isotope of Ra^{226}, its distribution and metabolism in the body may be considered to be identical with that of radium. The decay products are different, however, and one of these, radiothorium, is probably deposited in the organic matrix of bones rather than in the crystalline bone as is its grandparent mesothorium.[13]

The NCRP and M Subcommittee on Permis-

sible Internal Dose has made the estimate that the chronic damage of Pu^{239} relative to Ra^{226} for equal energy absorption is 2.5. If one takes into consideration the relative effective energies as well as the microcurie values and considers half the daughter products of Ra^{226}, this figure is actually closer to 5.

C. Effective Half-Life (time for radioisotope to lose half of its initial effectiveness by a combination of radioactive decay and elimination from the body)—Values listed in Handbook 52 are 44 years for Ra^{226} and 118 years for Pu^{239}. Brues calculates that if a body burden of Ra^{226} is measured some 25 years after the time of intake, the cumulative average dose to the skeleton is roughly twice that which would accrue on the assumption that the burden measured had been constant back to the time of intake.

Metabolism of Pu^{239} in Dogs and Man

When plutonium is injected intravenously in man and in Beagle dogs, there is considerable similarity in its deposition within the body.[8,14,15] The human excretion rate is less than that of the Beagles throughout the first five-year period following injection. Langham[8,14] calculated retention for humans as about 97% at 22 days after injection and 91% at 4 years, while the Utah study under the direction of Dougherty[15] shows about 88% and 72% for Beagles at the same times. Some tissue measurements by Langham and co-workers were made, and these authors estimated that 66% of the injected dose was deposited in the skeleton, 23% in the liver, 0.4% in the spleen, and 0.4% in the kidneys. This distribution was remarkably similar to that found in Beagles.[15]

Comparative Toxicity of Ra^{226} and Pu^{239} in Dogs

"A preliminary qualified comparison of the skeletal damage occurring in dogs injected with plutonium and radium shows, in general, a greater variation in plutonium dogs than in radium dogs. Bone tumors have developed in plutonium dogs with average skeletal doses of 1,100 to 7,400 rads and in raduim dogs over the range of 5,600 to 15,000 rads."[15] The earliest minimal changes are seen in the jaw at average doses of about 140 rads for plutonium and about 290 rads for radium.[16] In producing these effects, the comparisons indicate that for equal energy absorption Pu^{239} is two to five times as effective as Ra^{226}.

The doses to the liver and to bone of plutonium dogs are essentially the same, yet skeletal damage predominates.[17] This finding indicates that the assumption of uniform distribution is more valid for liver than for bone, which is in agreement with radioautographic findings.[15,17] It should be remembered that these comparisons are the averages for large numbers of dogs, with differences between individual dogs being quite large, especially with the plutonium dogs.

Comparative Toxicity of Ra^{226} and Pu^{239} in Mice

Finkel has studied the tumor-inducing and life-shortening effects in mice of the radioisotopes Ra 226, Pu 239, U 233, Po 210, Sr. 90, and Ca 45. Some 4,600 mice were studied, including 600 controls.[18] In her series, about 10 times as much intravenously injected activity in the form of Ra^{226} as in the form of Pu^{239} is required to give the same likelihood that a mouse will die of a malignant bone tumor.[18b] It should be remembered, however, that the Pu^{239} retention is about three times as great as the Ra^{226} retention in mice. She concludes, "none of the animal data support the hypothesis that the carcinogenic effect increases linearly with dose and that it has no threshold." Deposition of Pu^{239} exceeding 0.17 microcurie per kilogram were required to cause any measurable life-shortening.[18a] This would correspond to about 12 microcuries in a 70 kg man, or 300 times the maximum permissible deposit, if we could extrapolate from mice to man. Experiments utilizing larger numbers and varieties of laboratory animals are needed to better establish the relative effects of small doses of Ra^{226} and Pu^{239}, especially with respect to life-shortening. Such are in progress but require many years for completion, as test animals with life spans more nearly approaching that of man are included in the studies.

Effects of Ra^{226} Deposition in Man

The acute and subacute effects of radium and mesothorium exposure in workers are primarily jaw necrosis and aplastic anaemia.[19] Aub, Martland, and others have indicated that the more delayed chronic effects of radium deposits in the body of man are manifested as bone necrosis, neoplasia, and dyscrasias of the hematopoietic system.[13,19] The doses which resulted in acute effects were crudely measured and sometimes inaccurate. It seems probable, however, that some of the patients who died of acute radium poisoning contained about 100 microcuries of radium.[13] Hence, we are more concerned with the chronic changes which were often induced by much smaller doses.

Neoplastic or other changes in bone are the most prominent chronic effects of Ra^{226} in both animals and man. Such changes are also most prominent in animals bearing burdens of Pu^{239}. Hence we anticipate that such changes may

most likely occur in man due to excessive deposition of Pu^{239}. Our knowledge of the effects of radium deposition in man is based on studies of about 100 cases.[20] Hasterlik and Finkel[21] have studied some 70 additional persons and are investigating several hundred others who received exposures in the radium industry many years ago. These additional cases have not been reported yet. This represents only a fraction of the individuals known to be carrying an appreciable body burden of radium. Some 2,000 luminous dial painters were said to have been exposed in the early 1920's and are still living. There are probably an additional several hundred persons who drank radium water or received therapeutic injections of radium salts during the period 1915-1930.[22,23] Clark[24] has recently made a plea that physicians use unusual care in detecting radium poisoning in such people and reporting people with exposure to the Radioactivity Center at the Massachusetts Institute of Technology. People who were exposed but have no evidence of radium toxicity should also be reported in order that scientific studies may be made to correlate body deposition of radium with presence or absence of pathologic changes. Since these people have been harboring radium for some 25 to 40 years, knowledge concerning the effect would be of tremendous value in estimating the hazard of radium and, by comparison, plutonium, strontium[90], and other isotopes with long effective half-lives in the human skeleton.

Since some of the patients who have been studied absorbed mixtures of radioactive substances, it is difficult to estimate the amount or the distribution of the dose received over many years. Patients with pathologic changes are more easily brought to attention than are the unaffected people. Most of our data on human cases are summarized by Hasterlik, Aub, and their associates and the data prepared in tabular form by Neuman,[20] as shown in the accompanying Table, which is reproduced by permission of the author and Bulletin of the Atomic Scientists.

For the radium patients' age group, the incidence may be expected to be two to three times higher than this average. Neuman points out that if the tumor incidence in the radium patients were the same as in the over-all population, there would be less than 1 chance in 10 of finding a single bone tumor in this small group of 74 patients. Actually, 11 were observed.

It is clear from the above that Ra^{226} in amounts ranging from 0.1 microcurie to 23 microcuries increases the incidence of bone sarcoma by a factor of 100 or more. However, the

Tumor Incidence in Radium-Exposed Patients

Body Burden Microcuries	Exposure Time in Years	Bone Tumor Incidence* Tumors/ Patient	Tumors/Year/ Patient	Reference
8.0 -23.0	31	1/8	0.004	Aub et al.
2.0 - 7.0	27	2/9	0.008	
0.70- 2.0	31	2/9	0.008	
0.02- 0.5	—	0/4	—	
1.0 -10.0	25	4/21	0.008	
0.1 - 1.0	25	2/19	0.004	Hasterlik et al.
0.03- 0.1	25	0/4	—	
Average Natural Incidence†			0.00002	
			0.00006	Looney

*Epidermoid carcinoma of the nasopharynx occurred in three additional patients.

†The annual incidence is age dependent; 2/100,000 is an over-all average.

incidence was no greater in those with a burden of 8.0 to 23 microcuries than it was in those with a body burden of only 0.1 to 1 microcurie.

Only four patients with lower body burdens (0.03-0.1 microcurie Ra^{226}), are included in this study. The fact that no bone tumors were found in this group is not too significant. If the normal tumor incidence for the age group considered were increased by a factor of 10, the incidence would still be only about 1 in 67 for a 25 year period.

Marinelli points out that 19 persons with burdens of Ra^{226} below 0.4 microcuries who have been exposed to Ra^{226} have now been measured and reported on in the literature. Perhaps a thousand occupationally exposed women have been surveyed in the various states. These presumably have deposits of less than 0.4 microcurie and have no indication of bone sarcoma to date. In order to arrive at a realistic average burden for this group, he has considered seven dial painters previously reported in the literature[26] and an additional cancer-free group of 50 persons recently measured in his laboratory. Giving consideration only to subjects with less than 0.4 microcurie and at risk for more than 25 years, he obtained an average of 0.13 microcurie. Marinelli estimates that the incidence of bone sarcoma in this group, to give a 50% probability of showing no occurrence in a thousand women initially 25 years old during a period of 25 years of observation, would be 6.6×10^{-10}, which is 3.9 times the cumulative incidence in the unexposed Chicago population of the same sex and average age, observed for a comparable period of time. Using this figure together with those from all pertinent studies of exposed and unexposed groups to date, Marinelli has plotted a curve to show incidence of bone sarcoma in units of

average bone cancer mortality in Chicago for a 10-year period versus total radiation dose in terms of constant Ra^{226} burden. The curve bears a striking resemblance to the corresponding curve[18] for mice injected with strontium[90] and is greatly at variance with a straight line. The incidence does not appear to be proportional to dose at the very low doses, and suggests that a threshold effect for bone sarcoma does exist. Actual measurements and follow-up until time of death of this large group of radium dial workers is urgently needed to clarify this point. Auerbach is making a long-term study to compare the incidence of bone sarcoma in Chicago residents with that of residents in nearby communities in which the deposition of Ra^{226} in the skeleton is estimated to be about 15 times as great (7×10^{-10} gm) due to differences in content of Ra^{226} in the drinking water. Marinelli[25] reports that there appears to be no statistically significant difference in the incidence of bone sarcoma in the two groups, though a larger sample is needed for verification.

Maximum Permissible Radium in the Body

"There is substantial agreement that the presence of 0.1 microgram of radium 'fixed,' that is not being rapidly excreted, in the body has not been observed to be accompanied by deleterious effects, and, therefore, this quantity is currently defined as the permissible burden for man."[27] "This level was established in 1940 on the basis of late (7 to 20 years) effects noted in radium dial painters in the state of New Jersey; it was chosen by taking one-tenth the lowest body burden observed to be present in seriously injured workers and thus included an 'engineering safety factor' of 10."[25] In 1952, Hasterlik[27] found a body burden of only 0.52 microgram of radium in a former dial painter who had survived the amputation of an arm in 1932 for bone sarcoma of the head of the radius. He states further, "Significant non-neoplastic lesions are present in those individuals containing as little as 0.4 microgram of what has been shown to be only Ra^{226} uncontaminated with more than 0.66 per cent mesothorium."

With increasing knowledge, there has been a continued decrease in the maximum permissible amount of radium in the body. The decrease has been as follows: 1926—10 microcuries, 1936—1 microcurie, 1941 to date—0.1 microcurie. Since present studies cover only about 34 years of exposure, Looney[28] states: "It would seem advisable to consider lowering of the present MPC of radium until information becomes available on the effects of radium in man over a normal lifetime." Long-term studies are in progress to improve our knowledge in this field, but many years will be required to improve present knowledge appreciably. There is no assurance, however, that such studies will indicate any less statistical variation between individuals in their reaction to a given deposit of radium.

Relation of Bone Damage to Ra^{226} in Body

In the face of such uncertainties, it would be most difficult to predict the probability of bone damage occurring in an individual as a result of a deposit of Ra^{226} much larger than the maximum permissible deposit. It would be even more difficult to make such a prediction with respect to Pu^{239}, since an extrapolation from Ra^{226} would have to be made.

Measuring Body Deposition of Pu^{239}

It should also be remembered that it is often difficult to estimate the amount of deposition of Pu^{239} in the body when poorly soluble Pu^{239} is deposited in the lungs by inhalation[29] or in the flesh by penetrating wounds. The estimate of body deposit of Pu^{239} is made[8] by determining the alpha activity in urine and comparing with curves obtained by measuring the daily urinary output of Pu^{239} following the intravenous injection of a measured amount of soluble Pu^{239}. Poorly soluble Pu^{239}, retained in the lungs following inhalation or in flesh wounds, will be greatly delayed in reaching the blood stream and ultimately being deposited in the body or eliminated via the urine or feces.

A whole-body monitor is being constructed at this project which it is hoped will determine, with reasonable accuracy, depositions in lungs and deep flesh wounds of the order of a maximum permissible limit of Pu^{239} by measuring the small quantity of weak x-rays which are emitted. Its effectiveness remains to be determined. In any event, such a fixed installation is useful only for patients who may be measured at this plant. Depositions in very superficial wounds in amounts much less than a maximum permissible limit (0.04 microcurie—0.6 microgram) may be measured with an appropriate instrument using a sodium iodide crystal and scintillation counter.

Average Dose to Bone from Maximum Permissible Body Deposit of Plutonium

In comparing radiotoxicity of isotopes in laboratory animals and man it is of value to know the approximate dose to the critical organ. Bone is generally considered to be the critical organ in toxicity due to soluble Pu^{239} and Ra^{226}.

If we assume that three-fourths of the maximum permissible total body dose of soluble

Pu^{239} is uniformly distributed in 7,000 gm of bone, the critical organ, then the average dose to bone each day would be:

$$\text{Dose in rads/day} = \frac{\text{Co. d/min/microcurie.min/day.} \overline{E}}{\text{Wt. of organ in grams} \times 6.2 \times 10^7}$$

Where Co = quantity of material in the critical organ expressed in microcuries where there is a maximum permissible deposit in the total body

E = average energy of the emitter in mev.

6.2×10^7 = number of mev per rad

$$\text{Dose} = \frac{0.03 \times 3.7 \times 10^4 \times 60 \times 1440 \times 5.16}{7{,}000 \times 6.2 \times 10^7} =$$

0.00114 rad/day = 1.14 millirads/day

If we take the relative biological effectiveness for the alpha radiation from plutonium as 10, then $1.14 \times 10 = 11.4$ millirems/day = the biologically effective dose rate from a maximum permissible amount of Pu^{239} in the body = approximately 80 millirems/week. This equals 4,161 millirems, or approximately 4 rems/year.

Reparable and Irreparable Injury

It has been customary to consider that exposure to ionizing radiation produced two types of somatic injury, one reparable and the other nonreparable. This generalization is valid for many conditions in animals but has not been proved for all conditions. The average single dose of whole body x-radiation required to kill animals of a certain species is appreciably less than the average of the sum of two equal doses required to kill similar animals when the doses are separated by an interval of one month. Based upon experiments with fruit flies and mice, there appeared to be no reparable damage with respect to radiation-induced mutation, though this is now questionable.[30] Recent experiments with mice indicate that the mutagenic effectiveness of a fractionated dose of x-radiation is much less than that of the same dose given rapidly as a single dose.[30] Some scientists have inferred that there may be no reparable damage with respect to radiation-induced leukemia and life-shortening.[4a,c] This has been strongly contested by others.[4b,18,31,32] Radiologists exposed in the past to an estimated x-ray dose of some 2,000 rems over a period of about 20 years[33] apparently have not shown any statistically significant life-shortening.[4a] While the incidence of leukemia in this group is increased, the increase is not nearly as great as that expected from a much smaller single dose of radiation. Since 2,000 rems is "far in excess of the single mid lethal dose for man and since the increment in leukemia is much less than that observed in the more heavily exposed Hiroshima survivors, it would seem that a gradually accumulative dose is much less effective than the same dose received at one time.[4a]

Leukemia and Aplastic Anaemia

According to Furth and Lorenz,[34] "leukemia induction by radioactive substance has been described by handlers of radioactive substances," though not as a prominent phenomenon. In the studies by Aub and associates[13] and by Hasterlik[27] only one case of leukemia was found and this received too little study to be considered a proved case. This is in contrast to people who have had exposure of the bone marrow or the whole body to penetrating radiation. Lewis[4a] has summarized the data on the incidence of leukemia in groups of humans who have received external penetrating radiation. These data show that the incidence of leukemia is increased by relatively high dosage. Since Pu^{239} is deposited in more intimate relation to the marrow than is radium, its action in this respect might be quite different from that of radium. Its action might be more like that of acute effects of radiothorium in causing anemia, often of the aplastic type. At any rate, it would be even more difficult to estimate the increased probability of leukemia or aplastic anemia occurring as a result of a given deposition of Pu^{239} than to estimate the probability of bone changes. The probability of occurrence would be far less than the occurrence of bone pathology if we may base conclusions on radium effects in humans and animals and Pu^{239} effects in animals.

Length of Life

It has been demonstrated with laboratory animals that large doses of radiation shorten life by an amount roughly proportional to the dose. Mole[31] has summarized the various studies on life-shortening in laboratory animals to date. In these experiments the duration of life of animals receiving less than 10 rems per week has not been significantly different from that of the controls which received no exposure. Much larger numbers of animals would be required to validate results at low dosage, as there are many inherent sources of error in such tests. Reference to previous figures indicate that the weekly radiation dose to bone, due to a maximum permissible deposition of Pu^{239}, would be about 80 millirems/week. This would have to be increased by a factor of 125 to be in the range in which evidence of life-shortening has been demonstrated in animals. This figure is just half of the actual dose of Pu^{239} found in one study to cause any decrease of life in mice.[18c]

Genetic Damage

Pu^{239} is largely deposited in bone and a very small fraction goes to the gonads, according to

data presently available. Gonad exposure to the industrial population is added to the genetic pool, and with the relatively small number of persons potentially exposed to Pu^{239}, in industry, this source would add little to the genetic problem.

Incidence of Plutonium Exposure in Industry

At the Hanford Atomic Products Operation, hundreds of employees are engaged in the manufacture of Pu^{239}. During the 13 years of operation there have been only three employees, to our knowledge, who have received an internal deposition of plutonium in excess of the maximum permissible level (0.04 microcurie—0.6 microgram). Exposure to external whole-body radiation has also been low. It has averaged about 0.3 rem per man year in the monitored areas. The age-specific death rates for male and female employees at the Hanford Atomic Products Operation is appreciably less than that for the state of Washington, or the nation, or for the city of Richland, in which most of these employees live.[35] This would seem to indicate that if there are any adverse effects of very small exposure to radiation which might occur in a 13-year period they are more than compensated for by the socioeconomic and general health and safety conditions which exist at this project.

Conclusions

From the foregoing it may be concluded that while much work has gone into the establishment of the maximum permissible body deposit of plutonium, the figure is still tentative. It is based on the maximum permissible microcurie deposit of Ra^{226} after corrections are made to allow for differences in actual effects of the two elements when tested in laboratory animals and the known effects of radium deposition in a small number of humans. Based on such studies, it is expected that there would be considerable statistical variation among individuals in the amount of the deposition of Pu^{239} to cause damage and in the type and extent of the damage. If assumptions were correct, one would guess that deposits of Pu^{239} exceeding the maximum permissible by factors up to 200 (see the Table) would increase the annual bone tumor incidence in employees with such deposits by a factor of about 67 ($67 \times 0.00006 = 0.004$), since this is approximately the increased annual tumor incidence due to equally excessive deposits of radium. The annual tumor incidence among employees with such depositions would then be 4 per 1,000 after equilibrium has been established between the rate of exposure and the incidence of tumors. The maximum permissible deposition of Pu^{239} would have to be increased a hundredfold to approximate the range at which statistically significant life-shortening has occurred in laboratory animals.[31]

It would appear that we shall not, at any time in the foreseeable future, be able to predict with any degree of accuracy that plutonium deposition in an individual up to 100 times the maximum permissible will or will not cause appreciable injury manifestable in the lifetime of the individual. If we could predict that approximately 1 of 100 exposed employees with a given deposition would develop pathologic changes some 25 years later, we would still have to wait about 25 years before we could determine which one of the hundred employees actually received injury and was therefore entitled to compensation.

Should an individual bearing a burden of Pu^{239} develop a bone sarcoma, aplastic anemia, or leukemia, it would then be the difficult job of the physician, with the assistance of radiation specialists and use of knowledge of the type outlined above, to decide whether in his opinion the condition was or was not probably caused by exposure to radiation. If the diagnosis is radiation-induced illness, then it becomes necessary for compensation purposes to determine the major source of exposure. The major radiation exposure in such a case might have been from the Pu^{239} or other occupational exposure, or it might have been from repeated diagnostic or therapeutic procedures.

In general, we would see no reason for considering the risks of exposure to internal or external radiation in any other light than that which we use in considering the risks from excessive heat, toxic chemicals, smoking cigarettes, overweight, or crossing the street. From a medical standpoint, it seems logical to state that there is a harmful effect when nontransitory body injury, disease, or impairment develops as a probable consequence of earlier deposition of plutonium, not merely when the presence of plutonium in the body is detected.

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Industry's Role in Mental Hygiene

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A REPORTER once asked Dr. George Gehrmann, our recently retired Medical Director, why he introduced psychiatry to the DuPont Company. He replied in his characteristic succinct fashion, "We employ people, don't we?" And no matter how automated industry may become people will be with us. In addition to the skills for which they were hired, they will bring into the workplace their entire background of training and experience. Yesterday's adolescents become our future employees.

Although most people are born a fairly uniform product, the very adaptability and learning skill which set man apart from lower animals make it likely that he will develop into an individual quite distinct from others. Each of us, being the product of his own peculiar set of experiences, perceives his environment in a slightly different way and with a distinct set of values. If these values are realistic, they promote survival; if unrealistic, they may promote self-destruction.

The self-destruction impulses are not seen as such but reveal their existence only in the form of unrealistic behavior. For example, one of our safety supervisors reports that the causative agent in the case of accidental injury is usually found to have been under the complete control of the injured individual prior to the event. We find many instances of deliberate disobedience of safety rules or removal of mechanical safeguards provided for the employees' protection.

From such evidence one might reasonably deduce that such individuals were guided by very unrealistic standards of behavior, or, if they knew better, lacked the necessary self-discipline to act accordingly.

The plant medical personnel usually see the earliest signs of human failure and are often in the best position to point out the causes and do what is necessary to see that the individual is made aware of the realities of the adult world in the same way as they implement the requirements of physical hygiene. People in industry must in essence do what they can to fill the void left by deficient parental training, at least as far as the requirements for responsible behavior in the work place.

Perhaps even more important is management's responsibility, again with guidance from their medical personnel, to create and maintain a realistic mentally healthy environment in which the new employee may find himself, and the older employee keep his sanity.

Machinery and equipment behave in a fairly constant and predictable manner (barring the phenomenon known as the perversity of inanimate objects). Man, probably because he is an unspecialized, adaptable creature capable of learning, is not always so predictable. In large groups there is sufficient common background of experience that group behavior may be predictable to some degree on a statistical basis, but the individual remains an enigma.

Since all human behavior is motivated and motivations are usually unconscious, the individual finds even himself difficult to understand. How often have we all asked plaintively: "Now why did I ever do such a fool thing?"

The idea that all behavior is motivated is sometimes difficult to accept when we observe a man deliberately drinking himself to death or passing a line of automobiles at a high rate of speed over the blind crest of a hill. Professionals in the field of human behavior are well aware of a group of persons who seem to careen through life with what appears to be a total disregard of their own and their fellowman's best interest or welfare. They do not exhibit even the degree of responsible self-interest and dignity so beautiful to see in the lower animals.

In a recent address, our President, Mr. Crawford Greenewalt, characterized the organization as "nothing more than a slice of humanity and whatever individual dispositions may be present, it is the average, the composite which must

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prevail. Decisions made in the name of the organization are still human decisions, and, as organizations, we are still subject only to the human will. If we can concede that people in the main have decent and honorable instincts, it must necessarily follow that, when they join together, the character of the organization will average out at about the same moral level."

Industry then is really a small society but with an exceedingly realistic perspective. It has had and used the opportunity to experiment with mental hygiene methods, retaining those which proved useful and discarding those not. Society at large could well benefit from the results of these test tube experiments.

My entire industrial experience has been in the duPont Company, and I can speak only in terms of these experiences. The following is in no sense bragging but is given to establish the frame of reference from which I speak.

The history of our Company since the early black powder days in 1802 reveals a traditional concern for the welfare of its employees. The manufacture of explosives was a dangerous process in those days (it is considerably less so today), and despite safety precautions, accidents occurred. Owner-management as it was in that day assumed a moral obligation to the injured worker and his family which antedated the formal adoption of workmen's compensation acts. And, although our industrial relations plans have been maintained in a favorable relation to what was being done by industry generally, company management continues to seek further means of promoting the welfare of its employees.

The presence of a psychiatric section in our medical division is tangible evidence of concern. This section has been in existence for about 15 years and retains two full-time psychiatrists. We still consider it a research project in mental hygiene. Several other large industries have instituted psychiatric programs.

Company policy has kept pace with current concepts of man's needs and has attempted to fulfill these within the capability of human resources.

Job and material security, equitable pay scales, cost of living adjustments, opportunity for advancement from within the company, due regard for human dignity, opportunity for job satisfaction, economic advantages, such as thrift plans, Group Life and Accident Insurance, Blue Cross, a disability wage plan paying full wages for 13 weeks for nonoccupational illness or injury for employees with over one year of service, suitable holiday and vacation plans and a pension upon retirement are all provided. Comprehensive safety, medical, and industrial hygiene plans have made our plants a safer environment than the employee's own home. We have an Alcoholics Anonymous representative on our medical staff.

In spite of all these efforts we continue to have the run-of-the-mill personnel problems and some avoidable accidents, while absenteeism is somewhat better than national averages it is still a problem, and alcoholism, no worse than elsewhere, is an unsolved issue.

The national scene and other industries reflect a similar situation. The school system is generally considered below par; people panic at the slightest reverse in foreign policy or scientific progress; 4% of the nation's adults are problem drinkers or serious alcoholics; half the hospital beds are occupied by psychiatric cases, of which there are 200,000 new victims each year.

It appears to us that further research into mental hygiene is a next step to shed some light on such mass failure of people. Man's security, happiness, and mental well-being do not seem to have been greatly influenced for the better by past practice.

Our earliest experience in attempting to apply psychiatry to industry quite naturally brought to our attention only the most serious cases. The majority of our patients were the obviously failing employees. Most were absentee problems whose major disabilities were caused by psychosomatic illnesses and who had been referred by the plant physicians and nurses. Another group of individuals were personnel problems, referred by their supervisors, who were frustrated and bewildered because nothing they seemed to be able to do for their subordinates was effective in getting them to perform as did their fellow employees.

A few sought consultation to discuss their own anxieties and personal and domestic problems. Although the work performance in such cases was not obviously deficient, it was observed that aiding the workers to solve their personal problems not only gained for them deeper personal satisfactions but reflected in an improved job performance as well.

An analysis of 500 cases revealed the patient group to be equivalent to a random sample of the total plant population. Management, supervision, and wage roll employees appeared in the exact proportion expected by their over-all presence in the plant.

As the number of cases mounted, it became apparent that the patient group not only was suffering from obvious emotional illness but seemed to have fallen heir to an overwhelming proportion of life's misfortunes generally. These individuals had a 40% greater serious injury

experience than the rest of the plant personnel. They were responsible for the greatest part of absenteeism and were well known to the medical, safety, and personnel departments as being repeatedly in one difficulty after another.

Emotional illness had so disturbed their lives that their whole manner of living seemed totally inadequate for intelligent adaptation to the same environment the rest of their fellow men found quite acceptable.

The studies revealed that a relatively common denominator existed in that their entire way of life was one of emotional dependance. One characteristic of the emotionally dependent individual is that he always has something or someone, aside from himself, upon which to blame his troubles. He is the one who finds working conditions intolerable; he thinks that the boss is unreasonable; his wife doesn't understand him; the plant doctors are unfair; management discriminates against him; accidents always happen to him; besides, he is plagued with one "sickness" after another.

Review of the longitudinal pattern of a patient's life reveals that today's problem is but one more incident in a long series stretching back to his childhood. There we find that well-meaning but misguided parents and teachers nurtured the emotionally dependent state by treating the child as though he were qualitatively a different kind of creature who was intellectually and emotionally unable to meet any degree of challenge. Excuses were all too often accepted as an adequate substitute for performance. No reasonable standards were established toward which the child could aspire and thus train himself to become a competent, self-reliant adult. Such self-reliance certainly incorporates a healthy social adaptation, but social adaptation in the absence of independent responsible initiative is not sufficient or even possible.

Nor are things much improved through adolescence. Instead of being required to fulfill an ever-increasing level of responsibilities, our teen-agers are carried into young adulthood in a childlike state of dependency. No wonder they rebel negativistically against society's rules and become delinquents. They seek standards and guidance and find only a passive petulance and indulgence on the part of their elders. There is, for example, the woman who called the police because her son was unmanageable. The officers arrived and found her 4-year old child having a temper tantrum. Teen agers have strength, intelligence, and potentially competence but are neither encouraged nor permitted to use their talents constructively. Few people recall that Alexander the Great, at the time he was the conquering general of vast areas of Eurasia, was in his teens.

Our experience to date suggests that industry has no special psychiatric problem, since most emotional illness has its roots in early childhood training. While industry has not created any special problem, it has often been remiss in its failure to correct problems in its employees when they first appeared. Instead of setting realistic goals for these individuals who had obviously always made only a marginal adaptation to their sheltered home and school environment, it leaned over backward to meet their demands without recognition that the well-being, security, and sense of accomplishment so desired by the individual cannot be given by anyone but must be earned by self-disciplined efforts on the part of each individual.

It is difficult to comprehend how the relatively few hours and years spent in the work place can have very much significance compared with the 15 or 20 early formative years spent in growing up, except as industry continues to encourage the dependency already existing by futile efforts to meet the pathetic demands.

Industry has been blamed for and accepted responsibility for some of man's unhappiness, the amount of blame depending upon who is doing the complaining. For example, much is said about man losing his identity in mechanized automated industry. The chemical industry is about as highly automatic as any and has been for many years, yet among many hundreds of patients I have personally seen I have been unable to elicit any feeling of loss of identity or lack of the craftsman's satisfaction in a complete job well done. On the contrary, investigation reveals that few in the patient group have done their jobs well enough to create any sense of gratification, well-being, or security.

The failure to have elicited such conflicts may be mine, for other investigators report that they find them. On the other hand, in the majority of patients ample evidence of personal and domestic problems has been found, and correction of these problems has led to improvement in the physical and mental health of the employee.

The ancient Greeks had a definition of happiness which to me is also a definition of a state of mental health. They wrote that happiness came about through the exercise of the vital powers along lines of excellence in a life affording them scope.

We seem to have gone far in creating a civilization where man is freer, more secure, and healthier than at any time in recent history. If contemporary life does not afford man all the

scope he could desire, I can hardly conceive of one which would. Dr. F. W. Dershimer, my former chief, pointed out that "industry is one of the most realistic situations existing in our modern world. As such it is the testing ground on which the strengths and weaknesses developed by the early training of the individual become clearly apparent. The reactions of men and women in this real world disclose faults and virtues of school and home as did army life during the war. They also bring out the factors that cause functional mental disorders in so-called normal people. Psychiatric observations of these factors should, in time, supply us with data by means of which we can diagnose the important causes of psychiatric conditions and go on to develop effective measures for preventing them."

In general, then, we find the emotionally ill individual is in one way or another evading the reality of his existence, not really because he wants it this way but his early training was so deficient that he simply does not know any better way of life. A common failing is the apparent total lack of recognition of the need for leading an orderly productive life, not only to earn our daily bread but for any degree of personal security and happiness. This failing is a direct outgrowth of a state of emotional dependency prolonged far beyond any needs the child may have ever had. It is doubtful if *emotional* dependency is ever necessary, even for children. The child's necessary material dependency is quite a different thing from emotional dependency. Unfortunately, many individuals have learned that there is a perverted kind of security to be had in the dependency of illness, injury, or irresponsibility.

Public health and occupational medical personnel are primarily interested in preventive medicine. Obviously, true prevention must start in childhood or earlier, with the parents before they become parents.

As pointed out earlier, the realistic nature of industry contains the elements from which a program of mental hygiene may be evolved. Management will need the advice of medical personnel in the same way successful safety programs have been implemented with the guidance of safety engineers. First, of course, we must ourselves learn to distinguish safe from unsafe practices in mental hygiene. A group may show the same failures as does an individual and for the same reasons. For example, a unit of several hundred individuals had a record of many lost-time injuries although exposed to the same safety program successfully used throughout the company. Safety records, morale, and work performance were poor; absenteeism from psychosomatic illness, high. A study of the problem by their own supervision, on management's insistence that the poor performance stop, revealed that the group was a body of men without effective leadership, and, like an individual with a sick undisciplined mind, its behavior was self-destructive.

The correctness of the diagnosis was demonstrated when discipline was reestablished and the same people doing the same jobs accumulated 7,000,000 work hours without a single time-losing injury. All the other symptoms of the sick group improved along with their safety performance. These people without conscious awareness of their plight were destroying themselves just as does the emotionally ill individual when he lacks the disciplined leadership from his own nervous system.

From cases we have studied, in both individuals and groups, it has been clear that the basic element for a mentally healthy climate in any institution, is a leadership which can and does establish realistic standards of performance and by any fair legitimate means see that all individuals, including management itself, meet these standards with responsible behavior.

As those individuals who are making only an unhappy marginal adaptation because they do not meet the realities of their lives with responsible behavior discover for themselves the deep satisfactions inherent in successful accomplishment, they will gradually discard their former state of dependency. As they become addicted to the inner glow created by true independence and self-reliance, they will, in turn, create a healthier atmosphere in their homes and for their own families. In this way, perhaps, the increasing cycle of dependency will be broken and a realistic program of preventive mental hygiene become established. After all, many people come into contact with a work situation before or about the time they become parents.

No dependency is possible in a situation where each individual accepts responsibility for his own welfare and performs so well that he never need worry about external security for he has his real security internally.

In the final analysis human dignity, self-respect, and confidence cannot be given but must be earned by successful accomplishment. This is probably the only kind of security available in this mortal world.

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Topical Review

HYDROGEN CYANIDE

Hazards, Toxicology, Prevention and Management of Poisoning

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SINCE the literature on the subject of cyanides is quite voluminous, we have chosen to narrow the scope of this review by restricting consideration to hydrogen cyanide (HCN) alone. This delimitation has little effect on those sections dealing with toxicological and medical aspects, inasmuch as poisoning is a function of cyanide ion (CN) whether the latter originates from the acid or from soluble inorganic salts.

Death from exposure to HCN is a relatively rare occurrence, particularly in light of the tonnage in industrial use. Production of HCN is limited to a few major chemical companies which manufacture principally for internal consumption. Manufacture of 150,000,000 lbs. was reported for 1957, of which fully half was devoted to the synthesis of acrylonitrile and of which only an almost negligible percentage gained access to the merchant market. The latter is represented chiefly by sales for fumigation purposes. Remainder of production can be accounted for largely in the preparation of white cyanide, lactates, and resin monomers, such as acrylates, methacrylates, hexamethylenediamine, and adipic acid.

Chemical and Physical Properties

HCN was discovered by Scheele in 1782 through the action of sulfuric acid on Prussian blue; hence the earlier name of "prussic acid."

More recently, the compound was produced commercially by treatment of calcium cyanide with acid, the former being derived from calcium cyanamid as a starting material. However, with the upsweep in demand for acrylonitrile commencing within the past decade, the product is now manufactured almost exclusively by the high-temperature reaction of ammonia and natural gas (methane) over a platinum catalyst.

Liquid HCN is a water-white to bluish-white substance with a specific gravity of about 0.7 and an odor that is most accurately described as characteristic, but which some observers allege resembles that of "bitter almonds" or "peach pits." The liquid is miscible with water in all proportions, forming solutions that are only very weakly acidic and is infinitely soluble in alcohol and ether. It burns in air with a blue flame, boils at about 25° C, and has a flash point (closed cup) of —17.8° C (0° F). The density of the vapor is slightly less than that of air, and its explosive limits in air, by volume, range from about 5%, lower, to 40%, upper. The product, therefore, possesses significant fire and explosion hazard. All sources of ignition should be eliminated from the vicinity of handling.

Pure, anhydrous HCN is quite stable. Under certain influences, however, it may undergo decomposition and polymerization. This reaction is exothermic and autocatalytic and may develop explosive violence. Factors adversely affecting the stability of HCN are the presence of water, oxygen, peroxides, and alkalies, and the action of pressure and radiation. Conditions favoring stability are the presence of acids and certain heavy metals and storage under refrigeration. The product is customarily stabilized by the addition of acids such as phosphoric, acetic, oxalic, and sulfur dioxide. Stored HCN requires periodic checks on pH, temperature, pressure, and color. When decomposition begins, the color of the liquid changes through progressively deeper shades of yellow and brown to black, and it is best to absent oneself from the vicinity of large quantities that commence to exhibit this behavior.

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Detection and Determination

HCN is rather reactive chemically, and analytical procedures for its detection and determination are available to satisfactorily high degrees of specificity and sensitivity. Jacobs[1] describes a variety of methods that are applicable for different purposes. Boxer and Rickards[2] have reported a modification of an earlier method, which enables the isolation, concentration, and colorimetric determination of one part of CN in 10^{11} parts of solution with a precision of $\pm 1.5\%$.

The minimum concentration of HCN vapor detectable by odor is reported[3] as about 1 ppm by volume, although most persons capable of smelling it appear to be able to identify it only in minimal concentrations of 3 to 5 ppm. Use of the sense of smell for the purpose of detecting or identifying the presence of HCN has the virtue of simplicity, but beyond this it has little to recommend it. It requires training and experience, it is subject to obvious interferences and preexisting fatigue of the receptor sites, and there is considerable individual variation in olfactory acuity. Furthermore, the inhalation of HCN is dangerous. The authors know of instances in which men have become overcome at the first step of this system of analysis.

In some cases, a lacrimator, such as cyanogen chloride or chlorpicrin, may be added to HCN as a warning agent. While superficially this practice appears to have merit, its actual value is somewhat dubious. It is obvious that no other substance will have physical properties identical to those of HCN, and so absence of a warning is no guarantee of safety. Moreover, severe irritant effects from the warning agent may contribute to immediate disability of the victim.

For field purposes there are available a number of test papers and detector tubes which undergo color changes when exposed to HCN, the intensity of the change being roughly directly proportional to the concentration of vapor in the atmosphere. No field method should be entrusted for performance and interpretation to a person not familiar with its limitations. Vapor exposures in industry almost never are confined to a single chemical entity, and it is a reasonable generalization that no field method has yet been devised that is completely specific or does not have some limitation on the manner of its use.

Methyl orange test papers are commonly used for determining the presence of HCN in air.[4–6] These papers are orange in color, but the color changes to pink or red at relatively low concentration of vapor. If the paper does not change color within two minutes after exposure to a suspected atmosphere, the area is considered safe for human occupancy. These papers *must* be kept moist; they are ineffective if dried out. The color change is affected by vapor of strong mineral acids and hydrogen sulfide or high concentrations of vapor of ammonia or amines.

Detector tubes containing silica gel impregnated with orthotolidine are available commercially, whereby the presence of HCN in the aspirated air is indicated by the development of a stain of greater or lesser length, corresponding to concentration, on the reagent column. Results are unreliable in the presence of hydrogen sulfide, styrene, and nitric and hydrochloric acids. Prior exposure of the reagent to various organic solvent vapors will affect the length of stain that develops in response to HCN.[7]

Other field test methods are those which involve aspiration of a sample of the suspected atmosphere through an aqueous reagent in an absorption device, with the concomitant development of color in the solution in response to the pick-up of HCN. White[8] has described a method which appears to have many advantages.

Toxicology

CN is one of the most potent and rapidly-acting poisons known. These properties, coupled with relatively ready availability, account for the choice of cyanide salts as instruments of self-destruction and the employment of HCN vapor for the execution of criminals in some states. An attempt was made to use HCN as a battle gas in World War I, and approximately 4,000 tons were fired in artillery shells.[9] However, because of its extreme volatility, it is almost impossible to establish a lethal concentration in the field, and it is generally agreed that very few casualties were produced thereby.

Cell membranes are highly permeable to HCN, and the ready diffusibility of the compound enables its rapid absorption through any body surface such as the alveolar membrane, intestinal mucosa, or skin. Neither the liquid nor the vapor is irritating to the skin or membranes of the respiratory tract. Absorption through the skin in the liquid phase is prompt; in the gaseous phase it is somewhat slower but still may be of hygienic significance. In aqueous solution, HCN undergoes little dissociation ($K = 7.2 \times 10^{-10}$ at 25° C), and this circumstance undoubtedly expedites its dissemination through tissue, inasmuch as membranes, particularly the skin, are generally less permeable to ionic forms.

The toxic action of CN is fundamentally an

expression of its ability to form complexes with metal ions, a property of which wide use is made in some commercial applications of cyanide salts. In vivo, this activity is manifested in disturbances of various enzyme systems in which heavy metal ions, or relatively simple organic compounds containing them, serve as co-factors. Particularly susceptible to this action are heme-porphyrin complexes containing trivalent iron, including those oxidative enzymes and coenzymes whose functional integrity depends either on the maintenance of an atom of iron in the oxidized form or on its continuous oscillation between ferrous and ferric states. Complexes of ferrous iron such as hemoglobin, whether oxygenated or reduced, are relatively unaffected. Since the respiratory exchange of many aerobic cells is dependent almost exclusively upon CN-sensitive enzymes, the unique capacity of CN for toxic effect is readily apparent. The most important enzyme in this connection is cytochrome oxidase, whose function consists of the oxidation of the ferrous iron of one of the cytochromes with the simultaneous reduction of molecular oxygen, and which stands as a bottleneck in a system of electron transport through which funnels a wide variety of cytochrome-linked dehydrogenases.

CN inhibits the activity of many enzymes, which Bodansky[10] divides broadly into hematin and nonhematin types. Although the response of the nonhematin enzymes to CN is less well understood, there is no reason to believe that their inhibition is of any material significance in the problem of acute poisoning. Certainly, their susceptibility is of an entirely different order of magnitude. Concentrations of CN of as little as 10^{-8} M will markedly or completely block the activity of hematin enzymes such as cytochrome oxidase, whereas marked inhibition of nonhematin enzymes can be attained only by concentrations of CN of the order of 10^{-3} M.

Apart from its reaction with heavy metal complexes within the body, CN is subject to enzymatic conversion to thiocyanate, an ion which is relatively nontoxic acutely. This conversion is effected rapidly and quantitatively by an enzyme known as rhodanese or transsulfurase, first described by Lang,[11] which occurs in many tissues and is probably the purest example of a detoxication mechanism that can be cited. The source of the sulfur physiologically is not clear, but it has been well established that thiosulfate is a preferred substrate. Under ordinary circumstances, the body is capable of handling a small but continuous burden of CN, probably represented by an atmospheric threshold for man of about 30 ppm of HCN, so that a dosage that would be lethal if administered at once may be tolerated without effect if absorbed piecemeal over a period of 24 hours. If thiosulfate is administered prophylactically, tolerance for CN is greatly enhanced. Thus Chen and associates[12] found that dogs were protected against approximately three times a lethal dose of CN if thiosulfate was injected intravenously at the same time or immediately after the subcutaneous administration of CN.

The union of CN with ferric iron complexes is reversible, and if death does not intervene, retained CN is eventually disposed of via the transsulfurase mechanism and renal excretion. The transsulfurase reaction is apparently irreversible, but it is of interest to note that Goldstein and Rieders[13] have described another enzyme, "thiocyanate oxidase," which catalyzes the reverse reaction, namely, the conversion of thiocyanate to CN.

The lethal dose of CN has been determined by various routes of absorption for several species, including man. Results of oral doses must be interpreted with care, since the presence of food in the digestive tract may retard absorption. The most reliable data are those for man[14] where analysis of tissues shows that *absorption* of 0.5 to 1.5 mg./kg., expressed as HCN, is lethal. This is of the same order of magnitude as the lethal dosage determined for other species by inhalation or intravenous injection.

The maximum allowable average concentration of HCN vapor in air for an eight-hour working day has been set at 10 ppm by volume.[15] Effects of continuous exposure to other concentrations are believed to be as follows[16]:

20 ppm—maximum safe limit for prolonged exposure
20-40 ppm—slight effects after several hours
50-60 ppm—maximum tolerable for one-half to one hour
100-250 ppm—dangerous after one-half to one hour
300 ppm—may be lethal in a few minutes
3000 ppm—rapidly lethal

While CN has no therapeutic value, it does possess at low concentrations certain well-defined pharmacological actions, all of which are referable to its ability to induce anoxia at the cellular level. The receptor cells then respond as they would to a decreased oxygen tension. CN is a powerful respiratory stimulant and induces an increased rate and depth of respiration early in HCN exposures. The site of this action is not limited to peripheral chemoreceptors, since Brodie and Borison[17] have demonstrated a central stimulant effect attributable to an excitatory action on medullary substrates. The effect of CN on oxidative processes in the brain is reflected in a reduction of electrical activity of that organ, with depression extend-

ing progressively from above downward. Electrical activity of the gray matter of the cord is increased. The effect may be regarded as a transient functional decerebration, and the behavior of experimental subjects is consistent with this interpretation.[18] The effects of CN on the cardiovascular system are similar to those of anoxia, with the response of the myocardium being the most prominent.[19]

Signs and Symptoms of Poisoning

Because of the rapidity of absorption and action of HCN, signs and symptoms of poisoning appear very rapidly following the onset of exposure. Symptoms of mild poisoning include unsteadiness, weakness, vertigo, headache, and, occasionally, confusion. Somewhat greater exposures cause nausea and vomiting. In severe cases, syncope followed by coma is almost instantaneous. Respiration is rapid and deep at first but later becomes irregular, slow, and gasping. Pulse is weak and generally fast, although in some cases it may be slow, and there may be convulsions, dilated pupils, and involuntary micturition and defecation. The patient may go on to apnea and cyanosis with no perceptible radial pulse. Respiratory failure is the usual immediate cause of death.

For the industrial physician, diagnosis is rarely a problem; it is made on the basis of a history of exposure and the immediacy of development of typical signs and symptoms. The senior author (J. H. W.) has found that the characteristic odor of HCN is seldom if ever distinguishable on the breath of victims, even in severe poisonings by inhalation. Cyanosis has not been an important sign, possibly because of the fact that in a well-supervised chemical operation, the interval between the onset of poisoning and the administration of first-aid is relatively brief.

Treatment

As in any poisoning emergency, the first step in treatment is termination of the exposure. Rescuers entering a contaminated area to remove an individual overcome by HCN should first protect themselves by donning and testing a gas mask with an HCN cannister or self-contained breathing apparatus and by wearing rubber boots and rubber gloves. The victim should be removed to an uncontaminated area and kept comfortably warm, but not hot. One member of the rescue team should call a physician, while the others proceed immediately with artificial respiration and first-aid.

The basis of the therapy of CN poisoning is twofold: (*a*) promotion of the activity of the transsulfurase system in order to effect a more rapid conversion of CN to thiocyanate and (*b*) the provision of substances which can combine with CN and thus compete with essential enzyme systems for the ion. The first objective can be accomplished, as noted above, by the ingestion or intravenous administration of thiosulfate. The second can be attained by the induction of a methemoglobinemia in the patient. Methemoglobin is an oxidation product of the normal blood pigment, hemoglobin, and contains iron in the ferric state. It combines readily with CN to form cyanmethemoglobin, and thus preemptively binds quantities of the former that would otherwise be available for the inactivation of cytochrome oxidase. Furthermore, it has been shown in vitro that cyanmethemoglobin can reverse CN inhibition of cytochrome oxidase activity; presumably this can occur in vivo, although it has not been conclusively established. Induction of methemoglobinemia is a relatively simple procedure therapeutically, and several chemical agents have been proposed and used for this purpose.

Chen, Rose, and Clowes[12] in experiments with dogs, a species which is more susceptible to CN poisoning than is man, compared the relative antidotal effectiveness of methylene blue, nitroglycerine, amyl nitrite, sodium nitrite, sodium thiosulfate, and sodium tetrathionate, singly and in assorted pairs. Best results were obtained with sodium nitrite followed by sodium thiosulfate, a regimen which was capable of protecting the animals against 20 minimal lethal doses of CN. Sodium nitrite alone protected against four minimal lethal doses, and sodium thiosulfate alone protected against three minimal lethal doses. This combination was 10 times as effective as methylene blue. Amyl nitrite alone, by inhalation, protected dogs against four minimal lethal doses. Its action is rapid and brief, and it is used to expedite treatment, providing for an immediate effect while the intravenous antidotes are being prepared for administration. This combined therapy saved dogs even after respiration had ceased, so long as the heart continued to beat.

Jandorf and Bodansky[20] studied the therapeutic and prophylactic effect of methemoglobinemia produced in dogs or mice by inhalation of amyl nitrite, or in dogs by intravenous administration of para-aminopropiophenone, when these species were exposed by inhalation to HCN and cyanogen chloride. Their results showed that the magnitude of the protective effect was somewhat directly proportional to the degree of methemoglobinemia produced by either agent.

Many other substances have since been recommended for treatment of CN poisoning. In

general, they have been either more toxic or less effective or have not been used sufficiently to demonstrate superiority over the amyl nitrite-sodium nitrite-sodium thiosulfate method. The effectiveness of the latter has been well documented.[21-24] To date, Chen has accumulated data on 50 cases of CN poisoning treated by this method, with 49 recoveries.[24]

The introduction of other heavy metal complexes into the blood stream may also afford protection against CN by preferentially combining with this ion to the exclusion of cytochrome oxidase. Thus, Mushett et al.[25] found that vitamin B_{12a} (hydroxocobalamin) was capable of preventing in mice the toxic signs and death due to CN administration. Vitamin B_{12} (cyanocobalamin) was ineffective. In mice injected with CN followed by vitamin B_{12a}, some of the CN appeared in the urine as thiocyanate but a greater percentage was excreted as vitamin B_{12}.

Following is a regimen for the treatment of cases of severe poisoning which may exhibit unconsciousness or near-unconsciousness; slow, irregular, or gasping respiration, or apnea; or, at times, convulsions, or other features of serious illness as described above.

1. Start the administration of manual artificial respiration, or use of a suitable, proved, mechanical resuscitator, at once if breathing has ceased or is very slow and irregular. The Holger-Nielsen method of manual artificial respiration is recommended.[26] Continue it without interruption until regular respirations have been resumed. Examine the mouth for dropping back of the tongue, pull the tongue forward, and remove false teeth, loose bridges, tobacco, and other materials.

2. While giving artificial respiration, have an assistant use amyl nitrite pearls, one every 5 minutes for 25 minutes, if necessary (i.e., if no response). The pearl is broken and lightly wrapped in a handkerchief or gauze pad, and held about 1 inch from the victim's nostrils and mouth, for 15 to 30 seconds per minute until the strength of the amyl nitrite is spent.

3. The victim's exposed skin areas and clothing, as well as his shoes, should be carefully examined for any contamination by liquid HCN. Any contaminated clothing must be immediately removed and placed outdoors, and the involved skin areas quickly and thoroughly washed with copious amounts of water.

4. If the victim has not responded to the above, the physician should inject intravenously 10 ml. of a 3% solution (0.3 gm.) of sodium nitrite at a rate not greater than 2.5 to 5 ml. per minute. This is followed directly by 50 ml. of a 25% solution (12.5 gm.) of sodium thiosulfate at the same rate and by the same route as the sodium nitrite. Care should be taken to avoid extravasation. The patient should be kept under observation for 24 to 48 hours. A temporary improvement of the patient's condition after the initial medication does not insure ultimate recovery or indicate discontinuance of surveillance. When signs of poisoning persist or reappear, the intravenous administration of nitrite and thiosulfate should be repeated one hour after the first dose, in one-half of the original dose. Even if the patient appears well, a second injection of one-half of the original dose may be given for prophylactic purposes two hours after the first one.

5. If signs of poisoning persists or reappear, there may be continuing absorption of HCN from some source. Recheck the patient's skin and clothing.

6. Oxygen may be administered at the discretion of the attending physician. In the senior author's experience (J.H.W.), this has not been necessary even in the most extreme cases. Theoretically, it may be required if the degree of methemoglobinemia induced is great enough to result in a severe or prolonged anoxemia. A feature of methemoglobinemia not heretofore mentioned is the fact that the dissociation curve of the remaining oxyhemoglobin is shifted to the left, and delivery of oxygen to the tissues is impaired.

7. If the nitrites cause a profound fall in blood pressure, epinephrine or ephedrine may be administered to control this undesired effect.

[WARNING: Vapor of amyl nitrite is flammable, and its mixture with air may present an explosion hazard if a source of ignition is present.]

In less severe cases of poisoning, which may manifest any combination of weakness, vertigo, headache, nausea, and vomiting, interruption of the exposure, rest and symptomatic treatment effect very prompt recovery. If the exposure has ceased, these patients are usually free of symptoms before they are seen by the physician. It is rarely necessary to administer amyl nitrite. However, it should be given if there is any doubt whatsoever concerning its indication. Individuals who have been exposed to HCN should be transported to the physician's office; they should not be allowed to walk.

The prognosis in any case depends upon the dose of cyanide absorbed and the promptness of treatment. Even if breathing has stopped, one can expect recovery as long as the heart is beating.

It should be noted that some cases of HCN poisoning will be complicated by the presence

of traumatic injuries, e.g., skull fracture, incident to the sudden collapse of the victim, particularly if he falls from some height. If fractures of the ribs are sustained, the application of manual artificial respiration will present a problem.

The Question of Sequelae

Most investigators who have had the opportunity to observe and treat many cases of acute exposure to HCN are of the opinion that, if death does not result, recovery is complete and usually prompt. In our experience, we have not observed residual effects of any kind from acute poisoning. Nevertheless, reports appear in the literature of alleged sequelae to acute CN poisoning,[27-31] most of which deal with lesions in the central nervous system. Haymaker, Ginzler, and Ferguson[32] studied the effects on the central nervous system of acute CN poisoning in dogs and found necrosis of the gray matter in the cerebral cortex, head of the caudate nucleus, putamen, substantia nigra, globus pallidus, pulvinar of the thalamus, and cerebellar cortex in animals which did not die within three hours. On the other hand, Wheatley, Lipton, and Ward[33] found that repeated daily injections of CN, resulting in unconsciousness and convulsions, caused no pathological changes in the central nervous system of cats.

Since it is known that oxygen deprivation may result in damage to the central nervous system, and since the action of CN on tissues is the production of a cytotoxic anoxia, it is a reasonable assumption that it is possible for CN exposure, under conditions of sufficiently great intensity and duration, indirectly to effect permanent damage to the central nervous system. Any sequelae thus produced would not be a direct effect of CN, but rather an indirect effect of anoxia. It is estimated that irreversible damage to the cerebral cortex occurs after 5 to 10 minutes of complete anoxia, whereas the medulla may withstand from 20 to 30 minutes of total anoxia.[34]

Another effect of anoxia is an increase in pulmonary capillary permeability.[35] The authors are not aware of any cases of pulmonary edema following exposure to HCN, but the latter may render a person more susceptible during a period of several hours to development of pulmonary edema from subsequent exposure to a respiratory irritant in amounts ordinarily not sufficient to produce this effect. Foulger[36] described such a case involving a fumigator exposed first to HCN without becoming seriously ill, and then exposed later in the same day to methyl bromide with the development of pulmonary edema resulting in death.

The Question of Chronic Poisoning

Whereas many investigators firmly deny the existence of chronic CN poisoning, there have appeared occasional accounts of illness among persons receiving repeated exposures to CN in their occupation, particularly in the plating and case-hardening trades. Symptoms included asthenia, headaches, vertigo, irritability, loss of weight, anorexia, and various gastrointestinal complaints. These symptoms disappeared completely when working conditions were improved or employment was terminated, only to recur when the individuals returned to their former exposures. The illnesses were regarded as chronic CN poisoning.

Hardy[37] suggested a mechanism for the production of this clinical picture. In the detoxification of absorbed CN, the greater part is converted to thiocyanate, which is found extracellularly in the body fluids and which is excreted for the most part by the kidneys. Because the rate and amount of thiocyanate excretion by the kidneys is irregular, it is possible that an individual regularly exposed to HCN may progressively accumulate thiocyanate in his extracellular fluid. Studies of the toxic effects of thiocyanate in hypertensives treated with sodium or potassium thiocyanate reveal clinical pictures strikingly similar to those reported as chronic CN poisoning. In addition, some of the cases exhibiting toxic effects from thiocyanate have shown enlargement of the thyroid gland. Clinical observations of thiocyanate poisoning have been corrborated by animal experiments, including the production of goiters. On the basis of the above, Hardy suggested that chronic CN poisoning may be identical with thiocyanate intoxication. She reported two cases with thyroid changes[38] following occupational exposure to cyanide in the case-hardening industry.

Wutherich[39] described the case of a 39 year old man who received daily exposures to CN while engaged in dipping heated pieces of iron in a CN bath and who complained of loss of appetite, nervousness, vertigo, headache, and nausea with occasional vomiting. During absences of two to three weeks from work, the complaints completely disappeared, only to return a month after resumption of work. Following discontinuance of the exposure, the patient's symptoms could be reproduced by the daily intravenous administration of 1.4 gm of sodium thiocyanate.

Prevention

The cornerstone of prevention of HCN poisoning is education and training of the personnel who will be potentially exposed. An under-

standing of the hazardous properties of this material, the employment of protective measures, and preparedness for any eventuality are mandatory. In event of an emergency, there is no time to repair to the library for consultation of reference works.

In locations where HCN is handled, even in "closed" systems, there should be a "buddy" system whereby no man is permitted to work alone. This does not mean that men need be stationed side-by-side, but it does mean that they should be so located that every employee in a potential exposure area is under constant surveillance and auditing.

In using a gas mask, one should make sure that the cannister is intended for HCN, since the usual cannister does not protect against HCN. Because the resistance of the mask creates a slight vacuum in the nasopharynx on inhalation, it is possible for individuals having a punctured ear drum to "breathe in" HCN through the ear. This danger can be circumvented by the use of a properly fitting ear plug. In addition to the usual limitations on use of masks, the following precautions apply particularly to HCN. *Do not remain in high concentrations of HCN vapor longer than is absolutely necessary, since the gas can be absorbed through the intact skin.* As HCN is readily absorbed into clothing, the mask should not be taken off immediately after leaving the contaminated atmosphere.[40]

Because CN poisoning can be so rapidly fatal, there is no time to wait for a doctor or nurse when an accident occurs. Immediate first aid must be applied on the spot. It is therefore essential that all personnel assigned to areas where HCN is handled be well trained in the manual administration of artificial respiration, and have a thorough knowledge of first aid procedures in caring for a case of HCN exposure. Also, there must be conveniently located in each such area, a first aid kit[41] containing the following items:

- 2 boxes (2 dozen) of ampuls each containing 5 minims (0.3 ml) of amyl nitrite.
- 2 ampuls of sterile sodium nitrite solution (10 ml of a 3% solution in each).
- 2 ampuls of sterile sodium thiosulfate solution (50 ml of a 25% solution in each).
- 1 10-ml and 1 50-ml sterile glass syringe with sterile intravenous needles.
- 1 ampul file.
- 1 tourniquet.
- 12 gauze pads.
- 1 small bottle of 70% alcohol.
- 1 stomach tube.
- 2 1-pint (473 ml) bottles of 1% sodium thiosulfate solution.

Although HCN is a highly hazardous material, it has been learned through long experience that with education, preparedness, and observance of proper precautions, it can be used safely.

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Industrial Medical Aspects of Nuclear Technology

II. SOME FUNDAMENTALS OF NUCLEAR PHYSICS, HEALTH PHYSICS AND RADIATION MEASUREMENTS

Niel Wald, M.D., Pittsburgh

This is the second of a series of twelve reviews. Subsequent installments are scheduled to appear at quarterly intervals.

IN THIS section, the subject matter of which may seem rather remote from industrial medicine, we shall attempt to prepare the way for a future detailed discussion of nuclear technology, its hazards and their control. To accomplish this, a review of some of the basic developments in the field of atomic or nuclear physics should be of value. The following necessarily brief, and not overly technical, exposition of scientific progress along these lines from the days of the Greek philosophers up to our own time is therefore presented.

The Old Atom

While thinkers of many ancient cultures, including the Hindus, pondered on the nature of matter, it was the Greek philosophers of about 2500 years ago who formalized the concept that all material things are composed ultimately of invisible and indivisible particles. These Democritus called "atoms," from the Greek words "a" (not) and "temnein" (to cut). His school of "atomists" developed an atomic theory which included the indestructibility of matter and energy, fusion and fission, and a cosmology based on the conglomeration of atoms in a void to form matter and, ultimately, a universe. These concepts were unsupported by experimental evidence, of course. Thus, although amplified by thinkers such as Epicurus and Lucretius, they were successfully disputed by another eminent philosopher, Aristotle. They therefore received little attention until the European Renaissance, when such philosophers and scientists as Descartes, Galileo, and Newton again brought them up for consideration.

John Dalton, an English schoolmaster, took the recurrent philosophical speculations and, in the first decade of the 18th century, used them in a quantitative way by assigning weights to atoms. He thus predicted and explained chemical observations that elements combined in definite proportions by weight. The chemists and physicists of the day rapidly followed along this line of reasoning and added to it. Avogadro and, later, Cannizzaro, in Italy, developed a system for determination of molecular weight based on atomic weight and relative amount of the constituent atoms. By Avogadro's law, in a given volume of gas the number of individual molecules is independent of its chemical composition. A gram molecular weight, or mole, of any gas has a volume of 22.414 liters at standard temperature (O°C) and pressure (1 atmosphere). The number of individual molecules present in any gas under these conditions is 6.025×10^{23}, called Avogadro's constant. This number is the number of individual molecules in 1 gram molecule of any substance. Also, by dividing the atomic weight of any element by the Avogadro number, the weight in grams of a single atom of the element is obtained.

An English physician, Prout, in 1815, attempted to classify all atomic weights as whole number multiples of the weight of hydrogen. Unfortunately, this significant hypothesis failed because of the then unknown presence of several isotopes of various elements which produced some fractional atomic weights. Gradually, attempts to relate atomic weights to

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physical structure and chemical activity improved and culminated about 1870 in the periodic table of Mendelyeev. This demonstrated the predictability of repetition of physical and chemical properties of elements at regular intervals when they are arranged in order of increasing atomic weight.

A New Ray

The study of electricity also had come a long way from its early Greek beginnings. Benjamin Franklin investigated static electricity and developed the evidence for "positive" and "negative" charges in 1747. Galvani and Volta's work resulted in the wet battery and made possible further explorations. By 1838, Faraday took advantage of both this new tool and the newer knowledge about the physics of gases to conduct the first systematic studies of effects of electricity on gases under low pressures. Further studies in Germany, with improved vacuums, led to the eventual recognition of Goldstein in 1876 that the observed luminescent glow came from "rays" originating at the cathode of the tube, and hence he called them "cathode rays."

The exact nature of cathode rays was a challenging question which many scientists helped to answer. William Crookes, by 1885, had improved the vacuum discharge tubes and concluded that the rays were high-velocity, negatively charged particles emitted from the cathode. Hertz and others considered them electromagnetic wave vibrations of shorter wave length than light. It was felt that particles should be deflectable not only in a magnetic field but also in an electric one. Finally, in 1897, J. J. Thomson, an English physicist, was able to prove that an electric field did actually deflect cathode rays when low enough gas pressures were used.

Thus, it was established that the cathode rays were a stream of negatively charged particles—but what sort of particles? The answer to that brings us to the threshold of modern atomic or nuclear physics, for we must now consider the fundamental subatomic particles.

Subatomic Particles

Following the invention of the voltaic cell in the early 19th century, it was found by Faraday and others that an electric current would decompose a solution through which it passed. This process, electrolysis, resulted in the liberation of exactly 1 gram equivalent of any substance at an electrode for each 96,500 coulombs of electricity used. This amount of electricity, now called a faraday, was shown by Stoney to bear the same relationship to a postulated basic unit quantity of electricity as the atomic weight of an element does to the weight of a single atom. Hence, by dividing the faraday by Avogadro's number he arrived at a value for the unit of electrical charge. Stoney proposed the name "electron" for this unit.

By 1890 the concept of an "atomic" unit of electricity was widely accepted. It was applied to the case of solutions, in which every ion is associated with a definite whole number of electronic charges equal to the atomic or molecular weight divided by its equivalent weight. Then Townsend and, later, Thomson showed similar results for gases formed by electrolysis and by x-rays respectively. Eventually Millikan in 1917 further refined the measurement of unit charge in his oil drop experiment and after additional corrections by other workers with oil drop and x-ray diffraction methods, the current value is held to be 4.803×10^{-10} e.s.u. (electrostatic units).

Thomson studied the ratio of charge to mass, e/m, of negatively charged particles similar to cathode rays. He concluded that these, regardless of how produced, were made up of units having a negative charge "equal to the positive charge carried by the hydrogen atom (ion) in the electrolysis of solutions." The term "electron," originally defining the size of the charge, soon came to refer to the particles themselves.

As e and e/m are known for electrons, one can calculate the mass, m, as 9.108×10^{-28} grams, or 1/1837 of the mass of hydrogen. Since this particle is much lighter than the atom of the lightest element, it clearly qualifies as a subatomic particle.

More Rays

In 1895, at about the same time as the cathode ray tube was leading some physicists toward an understanding of electrons, another phenomenon was also noted. W. C. Röntgen in Germany observed that when he turned his cathode tube on, a nearby sheet of paper coated with barium platinocyanide showed bright luminescence. Also, photographic film in the vicinity became fogged. He realized that some invisible penetrating rays emitted from the cathode ray tube were responsible and called them "x-rays." It was next observed that x-rays could "photograph" opaque objects and could produce ions in gases. By 1912 it was realized that x-rays were a form of electromagnetic radiation analogous to light but of shorter wave lengths, about 10^{-8} cm, and that they were produced whenever a stream of high velocity electrons struck an appropriate material.

H. A. Becquerel in France heard a lecture concerning Röntgen's rays shortly after they were discovered. Since his father had studied

fluorescence, he had some materials at hand, including potassium uranyl sulfate. On exposing photographic film to this uranium salt he found an image, indicating exposure by rays similar to x-rays. The rays penetrated opaque objects and ionized air as well. Thus, in 1896, natural "radioactivity," as Marie Curie soon named the phenomenon, was discovered.

Becquerel and others noted in 1899 that natural radioactive rays were deflected like cathode rays in a magnetic field. Rutherford, using aluminum filters, showed that uranium emitted two types of rays. One, which was stopped by 0.002 cm of aluminum, he called alpha (α) rays and the other, about 100 times more penetrating, he termed beta (β) rays. Marie and Pierre Curie showed that beta rays were deflected in a magnetic field, and Dorn found the same in an electrical field. Becquerel, after further work, confirmed the fact that the beta particle was identical with the electron.

The alpha particle, studied at length by Rutherford, appeared to be a positively charged particle of rather large mass. He determined the e/m relationship to be half that of a proton, i.e., a hydrogen ion with a single positive charge. Thus the alpha particle could have been a hydrogen molecule having twice the mass of a hydrogen atom but still a single charge, or it might have been a helium atom with a mass four times that of hydrogen and carrying two unit positive charges. Both of these satisfied the e/m requirement, but Rutherford favored the latter concept, since helium liberation was an already known characteristic of radium and actinium. This choice was verified both by determination of the charge of an alpha particle as twice that of the elementary electronic charge and by an elegant experiment of Rutherford's in which an alpha emitter was placed in a thin-walled glass tube within an evacuated outer tube. After several days, during which alpha rays presumably penetrated through the thin inner tube wall, helium was shown to be in the evacuated outer tube by passage of an electrical discharge through it and analysis of the resultant spectrum.

Another form of radiation, discovered at the turn of the 20th century by P. Villard, of France, was not deflected in magnetic and electrical fields but was penetrating and darkened photographic film. These rays, which came to be known as gamma (γ) rays, were shown by Rutherford to be diffracted by a crystal. Thus, they joined light and x-rays as a kind of electromagnetic radiation, with wave lengths corresponding to those of very short x-rays. Indeed, the gamma rays differed from the latter only in being emitted from the atomic nucleus.

Particles and Antiparticles

As a consequence of the new understanding of electron production in the cathode ray tube, a search developed for similar but positively charged particles. Goldstein found "canal rays" of positive charge, named for the channels in the cathode through which they passed. These "positive ray" particles differed from the cathode rays not only in the sign of their charge but also in being actual atoms or molecules related to the particular gas in the tube.

Then, in 1914, Rutherford described a particle having the same mass as a hydrogen atom, and a positive charge of magnitude equal to that of the electron. This was a hydrogen ion from which one electron has been removed, presumably by collision in the tube, thus giving it a weight 1836 times that of an electron. By 1920 this particle carried the name "proton." While subatomic and of positive charge, it was still not the parallel of the electron.

Finally, in 1930, Dirac, a mathematical physicist gave mathematical evidence for the existence of the theoretical particle of positive charge and similar mass to the electron. This esoteric theory said that electrons could exist in two kinetic energy states—positive and negative. If external energy were added to an electron in the negative energy state, it could be released. This would leave a "hole" in the previously completely filled state of negative kinetic energy and the "hole" would act like a positive electron briefly until filled by any passing negative electron. This pair formation of negative and positive electrons would require over 1 Mev of external energy.

The proton was too long-lived and large to meet these theoretical requirements. In 1932, however, Anderson, in California, found a track on a cosmic ray photograph which could only have been produced by Dirac's hypothetical particle. He named the particle a "positron." Positron-electron pair formation was soon confirmed by cosmic radiation tracks and by the exposure of lead to beryllium bombarded with alpha particles from polonium. Also confirmed was the production of annihilation radiation when the "hole" is filled in.

Dirac's theory is not restricted to electrons, and "antiparticles" are postulated for all particles. In Berkeley, California, in 1955, for example, antiprotons were demonstrated by use of the Bevatron, a particle accelerator. In a confirmatory test, antiproton annihilation radiation was also shown.

The Neutral State

Another subatomic particle of great importance was proposed in 1920 by scientists of

three continents. This was expected to result from the neutralization of the charge of a proton by an electron, leaving an uncharged neutral particle having a mass of unity on the atomic weight scale. Rutherford visualized it as a combined electron and proton. With no charge it would be able to pass freely through matter and hence would be hard to detect.

Bothe and Becker in 1930 noted that alpha ray bombardment of beryllium resulted in emission of a very high energy radiation. Joliot and Curie found that when paraffin, which contains hydrogen, was exposed to this radiation, protons were ejected with great velocity. Electromagnetic radiation could not do this under the existing physical laws. Chadwick resolved the difficulty by postulating that the new rays were particulate and specifically that they were composed of the neutral particles, or "neutrons," hypothesized ten years before.

Much more recently, in 1956, but still in accordance with the hypothesis of Dirac, bombardment of liquid hydrogen (protons) with Bevatron-produced antiprotons resulted in neutrons and antineutrons. Although particle-antiparticle pairs such as the electron and positron, or the proton and antiproton differ in having electrical charges of opposite sign, the neutron and antineutron cannot so differ, being neutral. However, the difference in magnetic spin results in the particles acting like magnets with their poles reversed so that their magnetic fields are opposite to one another.

One additional nuclear particle should be mentioned. As a result of studies on radioactive decay of thorium, which has at one stage two alternative pathways for formation of the next decay product, it was noted that the energy differences were not the same for each pathway on completion of that step. Theoretically if the emitted β rays were given off at maximal energy the energy losses should have been equal, but they were not emitted with maximal energy. The problem was to account for the missing energy without violating the law of conservation of energy. Pauli suggested an escape from this situation which Fermi followed by postulating the emission of another particle.

This particle, now called a "neutrino," was to be electrically neutral, with a very small mass even when compared to an electron. In 1953 Reines and others were able to demonstrate the elusive neutrino, and its antiparticle, the antineutrino, has also been found. Subsequent work by Lee and Yang and others in 1956 and 1957 has shown that the neutrino and antineutrino differ to the extent that the spin of one is "right-handed" and the other is "left-handed." Thus the parity principle was found to be invalid for these and certain other particles undergoing weak interactions.

The New Nuclear Atom

At this point we have reviewed the history of the old "indivisible" atom and its newer subatomic parts. Now let us consider how modern physics puts the pieces back together again.

Up through the nineteenth century the atom was generally considered to be an indivisible rigid sphere without internal structure. Then the new particles and rays made reconsideration necessary. By 1905, many speculations were broached. Thomson, for example, incorporated electrons into an atom composed of a "sphere of uniform positive electrification" through which the negatively charged electrons moved about in a series of concentric shells. Lenard, of Hungary, thought of neutral "doublets," each made up of a positive and a negative charge. Nagaoka, of Japan, visualized an atom like Saturn with satellites composed of electrons orbiting about a central positively charged particle.

In 1906 Rutherford bombarded gold foil with alpha particles. Instead of undergoing a general decrease in velocity with some directional change, most of the particles went through unimpeded while others were deflected to a notable extent. This lattice-like effect could only be produced by sharply localized charges concentrated in a small volume containing most of the atomic mass. The experimental results indicated that the diameter of the nucleus is about 10^{-12} cm. Each electron has a similar diameter, while the whole atom's diameter is about 10^{-8} cm. This is 10,000 times larger than that of the nucleus, leaving much empty space through which fast moving particles can pass readily.

X-ray diffraction and alpha scattering studies showed that the unit positive nuclear charge carried by the nucleus of any atom is equal to the atomic number of the element. The number of orbital electrons is equal to the atomic number as well. The symbol Z represents all of these. Following this reasoning, it is evident that the proton, with its single positive charge, is a hydrogen nucleus which has lost its one electron, and the alpha particle, with its two positive charges, is a helium nucleus minus its two electrons. The orbital electrons play a major role in chemical reactivity and ionization.

Atomic Extranuclear Structure

For a better understanding of the extranuclear part of the modern atom, the study of atomic spectra has been of great help. The strong heating of an element produces radiation mainly in the visible and ultraviolet range which can be diffracted by a spectroscope into its com-

ponent wave lengths. The resultant spectrum is specific for a particular element and indicative of its atomic structure.

It was first thought that the spectrum was due to the energy radiated by the motion of orbital electrons. However, such continuous radiation of energy would result in the electrons eventually spiraling into the nucleus. Also the wave lengths would not be distinct as the electrons moved nearer and farther from the observer. Niels Bohr, a Danish physicist, in 1913 helped to solve the problem by suggesting that electrons do not radiate energy while moving in a closed orbit. He termed such a stable orbit a "stationary state" and postulated that several such states could exist, each having a constant energy differing from the others. The spectral line would be produced by the radiation of energy accompanying each jump or transition of an electron from a higher to a lower energy level. The frequency or wave length would be related by means of Planck's quantum theory equation. Thus the electrons of a substance absorbing energy would pass from the "ground state" (or lowest energy stationary state) to "excited states" (or higher energy stationary states). The spontaneous return to the ground state would liberate specific amounts of energy, producing spectral lines of specific frequencies. Further assumptions were made that the electrons have circular orbits and that the angular momentum is restricted to values which are integral multiples of a definite quantum. Using these assumptions, Bohr calculated the energies of the possible stationary states of the hydrogen atom. The resulting spectral wave lengths were determined and found to agree very well with the observed values, seemingly confirming the Bohr theory.

Electromagnetic Radiation

At this point some consideration of the process of electromagnetic radiation of energy is in order. Pythagorus about 500 B.C. considered light as particles projected from objects to the observer's eye, and Newton held the same view. Huygens, on the other hand, proposed a wave theory. Experimental work with diffraction and interference supported the wave concept. The greater speed of light in air than in water also favored this idea.

Gradually it was realized that radiations with wave lengths longer and shorter than those of visible light followed the same laws. Maxwell and then Hertz brought electromagnetic waves into the fold, and a spectrum from gamma rays at the shorter end up through x-rays, ultraviolet, visible light, infrared, and short-wave and long-wave radio waves was delineated.

However, when radiation from a radiation-emitting "black body" was studied, discrepancies in energy temperature relationships were found. Max Planck resolved the dilemma in 1900 by shifting away from the accepted view of the black body as a vibrator, oscillating at a frequency corresponding to that of the radiation is continuously absorbed or emitted. Instead, he postulated that energy transfer was occurring in discrete bundles of radiation which were integral multiples of an amount or "quantum" determined by the frequency of the oscillator. Thus the quantity of energy, E, for radiation of frequency f, is given as $E = hf$, where h is a constant known as the Planck constant.

Although Planck meant only to deal with absorption and emission of radiation, Einstein solved further difficulties in radiation propagation by suggesting that here too the concept of quanta, or "photons," pertained. This was supported by Compton's findings in 1923 that when an incident x-ray hit an electron of an atom of low atomic weight, the observed increase in wave length of the x-ray and the simultaneous recoil of the struck electron fit the concept of a collision of two particles, i.e. the photon and the electron.

The converse was postulated in 1925 by de Broglie and then verified experimentally that a moving particle can exhibit wave motion. Electron diffraction phenomena were utilized, and it became clear that the wave properties of electrons determine the limit of resolution of an electron microscope just as the wave length of light sets the limit for an optical one.

The wave-particle duality was further generalized by Heisenberg's uncertainty principle, and the resulting new concepts of wave mechanics served to unify physics and to resolve some previously difficult discrepancies in theories such as Bohr's atomic model, which we shall now consider again.

The Uncertainty Principle

The uncertainty principle of Heisenberg precludes the simultaneous exact determination of position and momentum or its related properties. This is because any measuring system for one of these will alter the other as it is being operated. Thus the methods of wave or quantum mechanics, in which the statistical probability of finding a particle in a particular place can be represented by an equation of the same form as that which describes the propagation of waves, must be applied to this situation. When this was done, certain of Bohr's assumptions could be dropped and mathematical consistency of the theory improved.

As a result, specific spatially defined electron

orbits are not possible, since the electron now is thought of as a particle whose position is a matter of statistical probabilities, or even as a cloud of electricity of varying density. For this reason, the neat portrayal of an atom with a central nucleus and electrons orbiting around it in definite paths is no longer correct and can be misleading. However, Bohr's concept of electrons rotating around a nucleus is still valid despite the indefiniteness of their paths and the idea of an allowable series of energy levels for each atom is retained.

X-ray spectra of elements also give useful data concerning extranuclear atomic structure. Where light spectra of elements show a periodicity of findings with increasing atomic number, similar to those observed with other physical and chemical properties, x-ray spectra show a characteristic wave length change in a regular manner. This is because the former are due to transitions of the outermost electrons which vary in arrangement in a periodic manner. The latter, on the other hand, are the result of different transitions which occur when energy gain ejects or raises drastically the level of electrons from an inner quantum level. The filling of the resultant gap by a higher level electron generates the x-ray spectral line. The types of x-ray emitted, called "characteristic x-rays," are distinguished by the letters K, L, M, N, etc., in order of decreasing energy. Since ejection of one of the two electrons in the first or innermost principal quantum level results in a K series x-ray as another electron moves in, this level is known as the K level or shell. Similar nomenclature (L, M, N, etc.) is used to designate the other levels of energy.

The K shell can contain up to two electrons. Then, as the atomic scale is ascended, the L level is used until it holds up to eight electrons. It is then filled and the next element's additional electron starts the M shell, and so forth. The maximum number of electrons which can be accommodated is based on certain characteristics of electronic energy levels. Four quantum numbers are required to specify the state of an orbital electron: The principal quantum number (n) for any postulated energy state; the azimuthal quantum number (l) related to the orbital angular momentum of the electron due to its motion around the nucleus; the orbital or magnetic quantum number (m) to account for the behavior of spectra in magnetic fields due to different spatial orientations of the orbit; and the spin quantum number (s) to account for previously unexplained close grouping of several spectral lines by indicating one of the two possible directions of spin.

Since the Pauli exclusion principle, enunciated in 1925, states that no two electrons in any atomic shell can have the same set of quantum numbers, the maximum permissible number of electrons for each shell can be determined. Thus there are 2 possible electrons in the K quantum group (n=1), in the L or n=2 group there are 8 possibilities, n=3 has 18, n=4 has 32, n=5 has 50, etc. However, observations show that when the outermost ring, other than the n=1, contains eight electrons the next goes to a higher principal quantum level regardless of available places in the lower one. Thus one finds regular repetition of properties on a periodic basis with each period ending with eight electrons in the outermost energy level.

One can see that if all transitions between all the possible states on all levels occurred with equal frequency there would be a fantastic number of spectral lines. Actually, the statistical probability of occurrence of some transitions is high and these are therefore called "allowed" transitions. The probability of many is very low and thus they are "forbidden" transitions.

Atomic Nuclear Structure

Once the concept of a high-density positively charged atomic nucleus gained support, the nature of its composition was sought. A bundle of protons was a likely possibility. Such a nucleus of mass A (atomic weight), would have had A positive charges. However, the nuclear charge was shown to equal Z (atomic number) which was half or less of A. The addition of A – Z electrons would have reduced the charge by half without adding much mass, but the stability of such a system was doubtful.

When the neutron was discovered, in 1932, Heisenberg suggested that stable nuclei of protons and neutrons might well occur. The combination of particles, called a "nucleon," filled many theoretical requirements and raised at least as many questions. One of the most intriguing is the nature of the forces holding together neutral and positively charged particles in such close apposition when like charges should produce violent repulsion.

It is evident that more than the coulomb force is at work, and that the other force must be much larger and attractive rather than repulsive. If this were not so, no nuclei would exist because coulomb force would disrupt them.

A step toward defining this unknown force is to measure the "binding energy" holding the neutron-proton combination together. Since Einstein's theory requires an equivalence of mass and energy, the difference between the mass of a proton and of a neutron, and that of the combined pair is the binding energy. This is 2.1 Mev.

If one then considers the motion of one particle in the field of the other, representing the potential energy as a well, and knowing the binding energy, one learns that the radius of such a well is about 3×10^{-13} cm and the depth about 20 Mev. Thus, the unknown force is confined to a very minute radius and, within it, is of tremendous size.

There is a type of close range force between molecules. For example, consider an ionized molecule of hydrogen, H_2^+, two protons and one electron. The lowest energy level of this structure results when the electron exchanges back and forth from the coulomb field of one to that of the other. An exchange force binds the particles together, and dissociation to a hydrogen atom and a free proton does not occur.

Although molecular exchange forces may occur in coulomb fields, it was conceived by the Japanese physicist Yukawa, in 1935, that exchange of an unknown nuclear particle in a different force field might hold the nucleon together. He anticipated that the mass of the particle would be 140 times that of an electron. In 1937 Anderson and Neddermeyer found such a particle, called a "meson," in cosmic radiation, and many types have since been produced in cyclotrons.

A distinctive feature of the exchange force is "saturation." That is, each nucleon tends to pair off and interact with the nucleon nearest it. Apparently 4 particles are the optimal number, and one finds no isotope of mass number 5 in nature. An explanation may be that two neutrons can occupy a given quantum with opposite spins, and two protons can, as well. The next particle must go to a different energy level and the exchange force then cannot operate. The force is not strongly dependent on the nature of the particles or the direction of their spin relative to one another.

Another postulated force counteracting proton-proton repulsion is the surface tension of the liquid drop hypothesis which views the nucleus as a fluid. Scattering experiments are being used to study these proton-proton relationships as well as other nuclear combinations.

An interesting change of relationship has been pointed out in the proportion of neutrons to protons as atomic weight increases. As elements become heavier, the neutrons increase disproportionately. Thus when the large nuclei are considered, the neutrons greatly exceed the protons. For example, the carbon nucleus has 6 protons and 6 neutrons, while the uranium nucleus has 92 protons and 146 neutrons. This relationship appears to be involved with nuclear stability.

Isobars, elements having the same atomic number but differing in Z (proton number) are rarely stable when the difference is only 1. The nucleus of heavier weight generally changes to the one of lighter weight and less energy. In contrast, isobars whose Z differs by 2 are stable, perhaps due to pairing. One sees this in an analysis of Z and N (neutron number) in naturally occurring isotopes, whose frequencies are: Even Z, even N—163; Even Z, odd N—57; Odd Z, even N—50; and Odd Z, odd N—5.

"Magic" stability numbers can be derived by virtue of closed outer orbital shells as in the case of orbital electrons from He (2), Ne (10), A (18), Kr (36) and Xe (54), for example. It will be noted that these are the inert gases and that their electron numbers are indicated parenthetically. In the case of nuclei, it appears that particularly stable nuclei are associated with N or Z numbers of 2, 8, 20, 50, 82 or 126. This suggests that nuclear energy level shells may exist, and that something similar to the Pauli exclusion principle may apply here as well.

In general, despite the various fascinating bits of information concerning atomic nuclear structure and the forces which determine it, it must be conceded that there remains much to be learned about this very important and challenging aspect of nuclear physics.

Summary and Preview

At this point, we have reviewed atomic theories, electromagnetic radiation concepts including the quantum theory, the discovery of radioactivity, the delineation of various subatomic particles and rays, and current ideas about the structure of the nuclear atom. We are now ready to consider, in the second half of this section, the process of radioactivity itself by which the unstable nucleus of an atom passes to a more stable state. Particular emphasis will be given to the forms and effects of the energy released in these processes and their accurate measurement from the standpoint of radiation health and safety.

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Editorials

Plutonium Toxicity

The article on plutonium toxicity in this issue forces us to shift gears several orders of magnitude from chemical toxicity in our concept of permissible body content and environmental concentrations. Such highly toxic stable substances as beryllium and nickel carbonyl have maximum allowable concentrations in air expressed in terms of a few micrograms per cubic meter, while the figure for plutonium is 34 *millionths* of a microgram per cubic meter.

Plutonium is a radioactive man-made metal not much heavier than radium. Like radium, plutonium emits alpha particle radiation, but unlike radium, plutonium emits little else. Therefore, it can cause no radiation damage when external to the body, since the short range alpha particle will not penetrate the stratum corneum. Once having gained entrance to the body, however, significant pathologic changes can be caused by very small amounts of plutonium expressed in terms of weight or concentration, and this fact is reflected in the maximum allowable concentrations that have been developed. It can only be speculated that, on the basis of animal work, the most probable chronic effect of sufficient plutonium in the body would be neoplastic or other bone changes. The most likely entry is by the pulmonary route. Absorption from the intestine is extremely small, and the absorption from infrequent contaminated wounds is slow.

The luminous dial painters and radium-treated patients of the 1920's now form a valuable source of toxicity data for radioactive elements. Some of these people have died from radium poisoning; many are alive with internal burdens of radium; many have not been located. Like several other elements, radium and plutonium which gain entrance to the body tend to concentrate in the skeleton. Once there, the natural removal rate is so gradual that it can be considered negligible. Estimation of the plutonium hazard to humans depends to a large extent on the known effects of radium in humans, and the study of the comparative effects of radium and plutonium in laboratory animals. Standards have been developed by laboratory experimentation, calculation, extrapolation, introduction of factors of safety, and inclusion of the "benefit of the doubt."

Despite the exposure of several thousand workers to plutonium over the past 15 years, there is yet to be recorded the first case of toxic effect from deposition in the body. Thus, contrary to the time-honored manner by which many of the well-known chemical hazards were defined, exposure criteria have had to be formed without benefit of epidemiology. It is, perhaps, the mere lack of human pathology from plutonium exposure that drives some to confuse *exposure* with *damage*, and to substitute the former for the latter in the context of hazard pay and compensation. There is no fundamental difference between nuclear and non-nuclear hazards in this respect. It is to be hoped that objective articles such as this one will help to dispel the misconception.

—Guest editorial by THOMAS S. ELY, M.D.

First Lady of Industrial Hygiene

Ninety years ago last February 27, Dr. Alice Hamilton was born. Editorially as well as by news articles her professional life has been heralded. There is one facet of her life, however, that the younger generation of industrial physicians and hygienists do not know or fail to appreciate fully. Dr. Hamilton started her career in medicine in the laboratory. Her interest was in pathology and bacteriology, not in the practice of medicine which would bring her in contact with people.

If we will go back to the turn of this century, we will note that the industrial workers of that day were truly underprivileged. Probably nowhere today within these United States could there be found a circumstance comparable to the common lot of the earlier American working class. By and large they were foreigners who knew not our language. They lived in slums where they were the object of abuse by the local police. The industrialist had no interest in the welfare of his worker. Trade unions were then not strong enough to gain the rights they believed in.

Prior to entering medicine, Dr. Hamilton's social philosophy was influenced by her sister Agnes. Agnes had been studying the socialism of Richardy Ely. "She was fired with enthusiasm for his program of Socialism and easily won me over," wrote Dr. Alice Hamilton in her autobiography, "Exploring the Dangerous Trades." With this background it is easy to understand that even while working as a pathologist and bacteriologist Alice Hamilton became a resident of Jane Addam's Hull House in Chicago. Here she met people; the poor, the downtrodden working people who lived in the slums where Hull House was situated.

The list of well-known persons who came to Hull House to study its program or participate in its activities is long. Among these was Gerard Swope, who became President of General Electric Company. His name is singled out because of a recent event to be subsequently mentioned.

Obviously, industrial hygiene as we now practice it would have become one of medicine's essential disciplines without an Alice Hamilton. But no one can doubt that, because of her, it had an earlier birth in America. It would be nice to believe that all of us in occupational medicine and industrial hygiene like it because we have a small touch of Alice Hamilton within us—the love of people, especially for those who are called the industrial workers. It is easy to see that that is the reason that Dr. Alice Hamilton became an industrial physician in a day when such a person was unknown.

In recognition of Dr. Hamilton's service, her ninetieth birthday caused a few of her friends to instigate a movement that would provide a lectureship in a teaching chair in her name. Initially this was somewhat discouraging because it became apparent that a few small contributions would not suffice. But about a week before these words were written, Gerard Swope Jr. sent to Harvard University a check for $5,000 as a contribution to the Alice Hamilton Fund. It was given in memory of his father and mother, life-long friends of Dr. Hamilton, and it represented the combined kindness of Henrietta, David, John and Gerard Swope Jr.

—Guest editorial by RUTHERFORD T. JOHNSTONE, M.D.

Change of Plans

It was the original intention of this JOURNAL to publish one chapter of Dr. Raymond R. Suskind's Topical Review on dermatology in each issue throughout 1959. It has come about, however, that the pressure of other work on Dr. Suskind demands that this rigid publication schedule be revised to be less exacting. The new schedule calls for publication on an alternate month basis.

THE 1959 ANNUAL MEETING

of the

THE CANADIAN PUBLIC HEALTH ASSOCIATION

will be held

in celebration of its 50th anniversary

at the

SHERATON-MOUNT ROYAL HOTEL

Montreal, Quebec

May 31 to June 3, 1959

Industrial Medical Association

THE PRESIDENT'S MESSAGE

D. JOHN LAUER, M.D.

A CHANGE of administration often signals a change of program and policy. This is not necessarily so in the Industrial Medical Association, though with each new administration there will be some change in the methods of initiating and carrying out programs. Over the years programs have evolved as a result of much thought and many discussions by the Association's officers and directors, its committees and counselors. Emphasis may vary from time to time as needs arise.

In the year ahead, it would seem important that through our Committee on Medical Care more attention be given to that subject. All too often we are busy with immediate, day-to-day work and tend to neglect keeping abreast of the rapidly changing picture as it affects medical care. Here, more incisive knowledge is necessary for the industrial physician. In fact, the field of medical care is thought of today as the "hottest" one in medicine. We must be alert and informed.

As members of the Industrial Medical Association, our tying bond is "an interest in industrial medicine." Our special training and experience may vary widely, our geographic locations and our opinions, but this is our strength and, at times, our weakness.

Our strength lies in a unifying interest in the health of the people who work. To the surgeons, this may mean the repair of injuries and the correction of their causes; to the internist, health maintenance of the individual and the recognition of incipient disease; to the toxicologist, the behavior and subtleties of industrial poisons, their diagnosis, treatment and prevention; to the teacher, the opportunity to present the development of disease in a homogeneous group; to the psychiatrist, the effects of the work-social environment upon the individual psyche; to all of us, something of each, depending upon our interests.

Our weakness is in that we may insist our own interest be the overriding one—the dominating one. If we permit this as an association, we not only constrict our horizon but invite splintering and remove our broad forum platform. Each of us is at once a teacher and a student. We band together to learn and to teach. It is necessary that we have the various medical specialties within our ranks. It is likewise necessary that we have other disciplines allied with us. But we must be regrouping constantly and in communication with one another. Our ways of doing this have been improving through formal papers at our Annual Meeting, through periodic meetings of the various component societies, through work on committees, through the district counselors, through communication with the home office and its various services, and finally, through the pages of our own JOURNAL OF OCCUPATIONAL MEDICINE.

We improve ourselves most when we advance our field. The heritage left us by those who have gone before is indeed one of practical knowledge and vast opportunity—knowledge to recognize disease and injury associated with occupation—but even broader, the opportunity to study disease in its development and to develop techniques and methods of prevention.

"No one reads a president's message!" So I am told—so I believe! In this first attempt we have painted with a big, heavy brush. Maybe a president's page would do a greater service were it provocative. We shall endeavor in the months ahead to provoke our readers into active assault. Maybe in so doing, through the exchange of views, the president's message not only can remain dynamic, but act as a cohesive force in the Association.

Book Reviews

REHABILITATION IN INDUSTRY. Edited by Donald A. Covalt. Price $6.00. Pp. 154. New York, Grune & Stratton, 1958.

This third in a series of "Modern Monographs in Industrial Medicine," edited by Anthony J. Lanza, was written by members of the staffs of New York University College of Medicine and Postgraduate Medical School. Early in the "Foreword" Dr. Howard A. Rusk emphasizes the principal message proclaimed by this monograph when he remarks that "nationally, there is an average time lag of seven years between the onset of disability in the industrially injured workman and his referral for rehabilitation services." In this interval the problems of rehabilitation may be compounded by undirected consultations, failure to carry out the recommendations of consultants, increasing confusion for the patient, and the patient's loss of confidence in physicians.

The entire first chapter is devoted to discussion of a doctrine that is reiterated and emphasized throughout the book—specifically, "early referral." This chapter is probably the most important to the industrial physician because of the implications of this doctrine for the success of rehabilitation measures: An estimated 80% to 90% of referrals to the rehabilitation center are for such secondary complications as deforming contractures, disuse atrophy, general deconditioning, and social and psychological problems — conditions that should never have been allowed to develop.

"Peripheral Vascular Disease" includes discussion of the questions (1) "How can rehabilitation procedures help in the treatment of peripheral vascular disease?" and (2) "In which way does the presence of peripheral vascular disease influence the conduct of rehabilitation procedures?" Comments concerning prevention of these diseases should be of interest to the physician in industry.

"Soft Tissue Injuries" makes a plea for "spending more time with the patient, reassuring him, and avoiding excessive studies and referrals" as measures for avoiding chronicity. Of particular interest is the observation that "a recent study of back injuries involving only the soft tissues revealed that nonindustrial cases required three to six weeks of care as against 46 weeks for the industrial case."

"Fracture Rehabilitation" emphasizes mobilization rather than immobilization as the preferred method of treatment in many instances. Muscle testing is outlined. Alleging that rehabilitation must be completed off the job, the authors maintain that "physical work very frequently requires spurts of effort" that preclude rehabilitation on the job.

"Peripheral Nerve Lesions," "Management of Patients with Spinal Cord Injuries," and "Head Injuries" consist primarily of background information—with the exception of the discussion of first-aid in the management of patients with spinal cord injuries.

One of the chapters having much direct applicability to industrial practice is that concerned with "Back Injuries." Emphasizing the structural and functional complexities of the back and the relative importance of back injuries in the field of industrial rehabilitation, the authors make a plea for minute detail and accuracy in history taking, which frequently can suggest, if not establish, a positive diagnosis. They also consider the social and vocational histories of critical importance. A detailed examination of the back is outlined. Stress and strain, fatigue, instabilities, and other causes comprise the etiological basis for subdivision of the discussion of diagnosis and treatment. The authors consider that "the anxiety state must be recognized as the major feature of low back pain in industry." Under the section on "psychosocial-vocational aspects" they raise the question, in view of the role of anxiety in etiology, "How then can the busy practitioner assume also the role of social worker, psychologist, and vocational counselor?" They find the answer in the "thick file" with "consultation reports leading nowhere." "In some instances the discrete recommendations of two or three consultants may be similar yet have never been carried out. But the authors have yet to find a social service report, a psychological-vocational evaluation, or *any evidence of a maintained contact with any one physician in such a case* [italics not in original]. Occasionally a psychiatric evaluation has been made and psychotherapy recommended but not carried out. Consultation without direction, as stressed in the first chapter, serves only to add to the patient's thorough confusion and loss of confidence in physicians and with ever increasing bitterness toward all the people who are giving him 'the run-around.'" The assumption, then, is that the busy practitioner or the industrial physician needs to play the role of coordinator — of maintaining contact.

"Rehabilitation of Industrial Hand Injuries" includes the moot contention that "all hand injuries necessitating more than a band-aid should be referred to a hospital to the attention of a skilled hand surgeon" and the therapeutic principle that "splinting of the injured part . . . must be maintained until the wound has healed, for moving a healing wound results in increased fibrosis"—a therapeutic principle in contrariety to that of "mobilization" stressed in a previous chapter.

"A man's occupation . . . may not only be the means to an end . . . but it may be the end or goal itself." On the basis of this thesis the author of "Vocational Placement of Disabled Workers" discusses "Man and His Needs," "Evaluation of the Injured Worker and the Job," "Counseling and Management of Vocational Problems," and "Current Policies and Practices of Industry in the Employment and Placement of Disabled Workers." In these discussions, he emphasizes the role of the social service worker, the role of the psychologist, and of the vocational counselor.

—E. LOWELL BERRY, M.D.

THE PNEUMOCONIOSIS PROBLEM, WITH EMPHASIS ON THE ROLE OF THE RADIOLOGIST. By Eugene P. Pendergrass, M.D. Price, not given. Pp. 146, with numerous illustrations. Springfield, Ill. Charles C Thomas, Publisher, 1958.

This is a small book dealing with a large problem. The text was originally the manuscript of a Caldwell Lecture delivered by the author before the American Roentgen Ray Society; hence the emphasis on the role of the radiologist. It is neither a comprehensive nor a systematic treatise on the pneumoconioses. According to his preface the author's effort was directed primarily toward a discussion of guidelines found helpful in the interpretation of the chest roentgenogram. Much of the text is devoted to the x-ray manifestations of silicosis and asbestosis, a field in which the author has wide experience. This is by no means another atlas of silicosis, however, as shown by the diverse headings listed in the table of contents. These include sections on the history of pneumoconiosis, types, pathogenesis, classification, roentgenologic considerations, tuberculosis, carcinoma, and rheumatoid arthritis in association with pneumoconiosis and even the physiologic diagnosis of pulmonary disease. Needless to say, the discussion of many phases of the problem is necessarily superficial.

For the most part the author has presented his material clearly, if not systematically, but occasional statements are made which are likely to be misconstrued. For example, on page 87 the author states, "We are now fully aware that nodulation is not necessary in order to make a diagnosis of silicosis in an unilateral massive lesion in a coal miner. The thoracic surgeons are not as convinced of that observation as we are at this time." Neither is the reviewer.

Altogether, this book can be recommended to the radiologist, for whom it was written. Those with some knowledge of the pneumoconiosis problem may prefer a richer fare. —PAUL J. BAMBERGER, M.D.

AIR POLLUTION MEASUREMENTS OF THE NATIONAL AIR SAMPLING NETWORK, 1953-57. U. S. Department of Health, Education and Welfare, 1958.

The main purpose of the National Air Sampling Network is to assemble basic data of the nature and extent of air pollution throughout the nation. Two hundred twenty-nine pages of tables of air pollution data from several hundred sampling stations located in all 49 states, Washington, D.C., Hawaii, and Puerto Rico form the main body of the volume. Most cities had only one sampling station in operation, and the reader must realize that the data presented are subject to many variables, such as location of the sampler, meteorological considerations, surrounding structures, special sources of pollution, and many more.

Each sampler pulls approximately 7,000 cubic feet of air during a 24-hour period through an 8 by 10-inch fiber glass filter. This filter is capable of removing practically 100% of all 0.3 μ or greater particulates. The filters were analyzed for organic and inorganic pollutants and for radioactivity. The inorganic pollutants are separated and analyzed quantitatively for 26 separate substances which include nitrates, sulphates, and many metals. The method of analysis, the selection of samples, and the location of samplers are described.

While the authors recognize the limitations of the value of their data, the volume will give the reader some idea of the amount of various substances, organic and inorganic, in the air taken at the particular sampling stations.

The tabulations present the best information presently available in the United States and can be used for comparison purposes with data from communities where an air pollution problem is believed to be present. —JAN LIEBER, M.D.

Letters

TO THE EDITOR: I think the Journal offers an excellent medium to convey to students and young physicians the philosophy and the concepts of occupational medicine for which the IMA stands, as well as some of the information its practice requires. It should, therefore, be in every medical school and hospital library where it may attract the attention of medical students, interns and residents, as well as physicians engaged in private practice.

I am sure that most of the medical school librarians are aware of this and will soon, if they have not already done so, requisition subscriptions to our JOURNAL. However, the funds available for most hospital libraries are very meager and are usually pre-empted by items specifically requested by members of the staff. I would like to suggest, therefore, that all of the members of the IMA who have hospital affiliations be urged to donate a subscription to the JOURNAL to the library of one or more of these institutions. In case of duplication, I believe the librarian may be able to exchange the extra copies with other libraries for items they might not be able to obtain directly, or apply the duplicate donation to an extension of the original subscription.

To start the ball rolling, I would like you to enter a one-year subscription to the JOURNAL for the Medical Library of the Beth Israel Hospital, 10 Pearlman Place, New York 3, N.Y. I would appreciate your acknowledging this subscription order in a note to Mrs. Flora Ortman, the medical librarian at the hospital, and your sending the bill to me at the above address.

LEON J. WARSHAW, M.D., Medical Director
Paramount Pictures Corporation
New York 36, N.Y.

Several members have already donated subscriptions to hospitals and medical school libraries. We would welcome more such subscriptions, but urge prompt action if it is desired to start the subscription with Volume 1, Number 1, as the supply of back issues is limited. The cost of a one year subscription is $10.—Editor

Abstracts of Current Literature

Dermatology

William R. Buckley, M.D.

A Review of Dermatosis Among Office Workers: "Insect Bites." G. E. Morris.* Compensation Med. 10:3 (June-Aug.) 1958. (*520 Commonwealth Ave., Boston 15)

A common insect producing pruritus in office workers is the flea. These are usually carried in by a fellow worker who has a pet animal at home. On occasion, maintenance men employing a cat as a rat deterrent in the office building may introduce the flea. Another pest commonly found is the bedbug. These are more frequently found in places where people remain seated for prolonged periods of time. With both the flea and the bedbug, although many people are bitten, only a few develop irritation from the bites.

The most common insect producing dermatitis is the sarcoptid of scabies. Morris believes that scabies is by no means uncommon on office workers, though some physicians report seeing it only infrequently today. Other parasites causing skin difficulty are lice and mites.

Delusion of parasitosis is extremely rare in Morris' experience—only one case, indirectly produced, in a five-year period of time.

Penicillinase-Proved Allergy to Penicillin in Poliomyelitis Vaccine. M. C. Zimmerman.* J.A.M.A. 167:1807 (Aug.) 1958. (*School of Medicine, Department of Medicine (Dermatology), University of Southern California, Los Angeles)

Zimmerman discusses allergic reactions in six patients given injections of poliomyelitis vaccine which were due to traces of penicillin present in the vaccine. The criteria used to pinpoint penicillin may be listed as follows: (1) All patients had previous allergic reactions from penicillin therapy; (2) the reaction following poliomyelitis vaccine duplicated the previous allergic reaction from penicillin; (3) rapid clearing of the reaction followed the use of penicillinase; (4) no reaction followed injection of a brand of vaccine containing the same allergens except penicillin. The author points out that patients should receive a penicillin-free vaccine if they give a history of previous penicillin sensitivity. If this is not possible, penicillinase should be used prophylactically prior to the vaccine injection.

NOTE: Apparently, at the time this article was written, penicillinase had not produced any untoward reactions.

An Anaphylactic-Type Reaction Attributed to Penicillinase. S. Caputi.* New England J. Med. 260:432 (Feb.) 1959. (*Formerly, acting chief of dermatology, United States Naval Hospital, Newport, R. I.)

An anaphylactic-type reaction has been reported by Caputi from penicillinase therapy in the case of a 5-year-old Negro child. The drug has previously been reported as safe for use. It has assumed an important place in the treatment of allergic reactions due to penicillin.

Penicillinase is a protein enzyme obtained from Bacillus cereus, Escherichia coli, and numerous strains of staphylococci. It catalyzes the hydrolysis of the lactum-ring configuration in penicillin to the innocuous penicilloric acid counterpart. To elucidate the possible mechanism of allergy when no previous exposure to penicillinase could be documented, Caputi points out that many patients harbor penicillin-resistant strains of bacteria capable of producing penicillinase. Presence of the latter in the body could cause an altered state of sensitivity in certain cases and so set the stage for subsequent allergic reactions when the drug is given. Caution is urged on the indiscriminate use of this drug.

Changes in the Ten Commonest Dermatoses in Private Practice. E. F. Corson,* H. A. Luscombe, and J. K. Corson. A.M.A. Arch. Dermat. 79:179 (Feb.) 1959. (*131 S. 16th St., Philadelphia)

The authors compare the diagnosis of the 10 most commonly encountered skin diseases in private practice circa 1930 with an equal number of dermatosis seen in 1955.

The trend is of general interest. For example, contact dermatitis advanced from 3.1% to 11.1% in the 1955 series. The reason for its advance was twofold, according to the authors: (1) increased diagnostic ability, and (2) the many new allergies in industry and everyday use. Impetigo, 4.7%, and scabies, 3.2% in the 1930 study, did not qualify in 1955 as among the top 10. Better personal and public hygiene was said to account for the latter findings. The Tineas (all types) dropped from about 13%, first place in 1930, to 6.1%, sixth place in 1955. There is considerable doubt as to what may have produced this decrease. The authors suggest that perhaps the well-advertised proprietary preparations sold over the counter have allowed more patients to treat themselves successfully.

Laboratory Studies in a Series of Biologic False-Positive Reactions. J. E. Miller,* M. Brodey, and J. H. Hill. A.M.A. Arch. Dermat. 79:206 (Feb.) 1959. (*Department of Dermatology, Columbia University College of Physicians and Surgeons, New York)

The exact significance of the biologic false-positive reaction occurring in one or more of the standard tests for syphilis is as yet unknown. This report concerns 79 patients with biologic false-positive reactions who were studied with a battery of laboratory tests which included the following: serum electrophoretic patterns of the Durrum type and/or protein partitions by the Howe method,

cephalin flocculation, thymol turbidity determinations, sedimentation rates, heterophil, Brucella, cold agglutinins, cryoglobulins, L.E. preparations, Coombs test, complete blood cell counts, and urinalysis.

Some 67 patients showed no evidence of clinical disease except for the biologic false-positive reaction; 47 showed abnormalities in the laboratory tests done, and 12 patients had clinical evidence of disease.

NOTE: Physicians employed in industries utilizing a standard test for syphilis in their preemployment laboratory examinations must occasionally interpret a biologic false-positive reaction. It is well to review the criteria upon which such a diagnosis is made, and the laboratory tests advocated to rule out systemic disease.

Medical Care Administration

Asa Barnes, M.D.

The Practice of Medicine in an Industrial Society. W. P. Shepard.* Indus. Med. & Surg. 25:201-204 (May) 1956. (*Metropolitan Life Insurance Company, New York City)

We live and practice medicine today in a new era. Someone has referred to industrial physicians as the "coming generation." Some major sociological changes affecting the practice of medicine are: population migration within the country, enormous demand by the public for various forms of prepaid medical and hospital care, ruling by the court that "fringe benefits" including health care, might be bargained for in lieu of increased wages and a sudden awakening of industry to the value of an industrial medical program.

We are surrounded by man-made hazards to life and health, the variety and extent of which were never before seen in the history of the human race.

The industrial physician of the future will need to have the following qualifications and skills: (1) Employed by management or union, or both, his primary and sole function will be to apply his medical knowledge for the benefit of all from top executive to unskilled laborer. (2) He will recognize the importance of the profit motive and that he is expected to join his skills with all others in industry to reduce all possible loss. (3) He will offer workers and management alike the unique skills of medicine in proper job placement. (4) He will cultivate friendly professional relationships with his medical colleagues in the community. (5) The company doctor will recognize that community health facilities are as important to industry as industry is to the community. (6) He will provide invaluable service to management, the employee, and the local jurisdiction on workmen's compensation cases. (7) He uses his industrial health program as the place for the practice of preventive medicine. (8) He will find and develop opportunities to pursue special interests in the many fields about which we need further enlightenment. (9) Will lay out for himself a program of in-service training to keep him abreast of rapid changes occurring. (10) Will prepare himself for the specialty board examination.

The Community Responsibility for Medical Care. James P. Dixon.* J. Am. Pub. Health A. 49:76 (Jan.) 1959. (*Department of Public Health, Philadelphia)

Within our cultural setting the general nature of public responsibility in the provision of medical care services may be listed as follows: There is placed upon the public body a responsibility to protect, preserve, and promote the health of the body politic to withstand the impact of preventable medical scourges; establish standards and regulations that affect health and medical care; provide direct medical service to people for illnesses of a specified nature, such as mental illnesses, tuberculosis and others; and have responsibility for special beneficiaries to government such as veterans, dependents of service personnel, and American Indians. Finally the government, particularly the federal government, has become increasingly involved in the capital financing of hospitals, health centers, and diagnostic clinics for the use of the entire community.

Government must take the responsibility to assure that proper planning, counseling, and leadership are incorporated into our community effort for better medical care. To insure success of such planning, government must learn to be less supercilious about the ultimate worth of the voluntary health movement, and the voluntary health movements must accept the fact that government does have a large sanction from the people for planning and provision of services. Trends indicate that the role of government in this matter may be increasing.

Consumer Spending for Medical Care Progress in Health Services. Health Information Foundation, New York. December, 1958.

As a part of their rising standard of living, American consumers are spending more money on medical care than ever before in their history. Today, proportionately more than formerly is being spent for hospitals, for the cost of health insurance, and for ophthalmic products and orthopedic appliances. A smaller share of the medical care dollar now goes for physicians', dentists', and other professional services, while that for drugs and drug sundries has been relatively constant.

In 1929 medical care took 3.7% of each dollar spent for consumer items; in 1957 this figure was 5.3%. Medical spending usually runs higher when income is higher, but the increasing absolute amount of medical spending with rising income actually constituted a consistently decreasing proportion relatively. Medical spending accounted for 14.5% of the income of families in the under

$1,000 class and 6.1% for $1,000-$2,000, while for the $10,000-and-over families the figure was only 2.4% of income.

Mutual Relations of the General Practitioner to Industrial Physicians. R. Lomax Wells.* West Virginia M. J. 55:55 (Feb.) 1959. (*Chesapeake and Potomac Telephone Companies, Washington, D.C.)

The author outlines the activities of the medical department of the Chesapeake and Potomac Telephone Companies with specific emphasis on the sickness benefit and payments for sickness absences for the 5,602 employes of the West Virginia Company during 1957. Non-occupational sickness and accidents cost the company $371,130 as contrasted with a relatively small cost of $11,743 for lost time accidents occurring on the job.

The company has a well-planned employee health program to promote health and prevent illness, but it must depend on the private practitioner of medicine to treat the nonoccupational illnesses. While this practitioner has his first obligation to the patient, he also has an obligation to the employer who is paying the patients' sickness absence benefits. Sickness absence is a very real and very costly problem to industry, and the industrial physician needs the assistance and cooperation of the personal physician especially on problem cases. Diagnosis needs to be accurate, and there needs to be a reasonable estimate of return to duty. The cooperative approach, with the industrial physician giving primary emphasis to preventive health measures and the private practitioner directing his energies to the curative area, should provide the individual employee with a better health status. There need not be disagreement between the two areas of activity.

Health Education in an Industrial Setting: Report of a Long-Term Community Project. Mary D. Hazen, Beryl J. Roberts, and Marjorie A. C. Young. Cambridge, Mass., Harvard School of Public Health, October, 1958.

This is the report of an industrial education project which grew out of a community interest in Cambridge, Mass., and which combined research with service in health education. The project became the Cambridge Industrial Health Information Service in 1955, and research aspects were emphasized from that time on.

About 25% of selected plants approached with respect to health education programs can be expected to undertake a questionnaire assessment of employee interests and needs. The remaining plants will be interested in such data but will regard the questionnaire as time consuming.

Time is required to involve in-plant health education programs. Generally speaking, management is interested in health education in industry as evidenced by reception of this project. Employee response to health education programs appears to be highest in those plants where management support and interest is highest.

Abstracts

There is evidence that community health agencies wish to coordinate their services in health education. Additional studies are needed now to find patterns of health education appropriate to the industrial setting and, at the same time, sound from an educational standpoint.

Labor, as a force in the establishment of in-plant health education, was not sufficiently explored in Cambridge. The authors recommended that the role and interest of labor be investigated more fully in future community programs in industrial health education and that labor as well as management be brought into the community planning phases of the work as well as planning for individual company programs.

Internal Medicine

Shermer H. Stradley, Jr., M.D.

Spontaneous Strokes in the Young. H. Stevens.* Ann. Int. Med. 49:1022 (Nov.) 1958. (*George Washington University School of Medicine, Washington, D.C.)

The spontaneous occurrence of cerebrovascular accidents in normotensive healthy young people is not rare. The author reports on 32 such patients.

Two categories of strokes occur in the young. (1) Cerebral venous thromboses, which may be subdivided into (*a*) infantile hemoplegia, (*b*) puerperal hemoplegia, and (*c*) venous thrombosis of pregnancy, and (2) cerebral arterial thromboses, which may affect (*a*) the carotid artery, (*b*) the middle cerebral artery, and (*c*) other arteries of the circle of Willis.

It is emphasized that carotid arteriography, although at times indespensable to exclude brain tumor or aneurysm, should not be used indiscriminately. Carotid artery occlusion can often be diagnosed clinically, the cardinal sign being predominantly hemiplegia with a history of contralateral headache. Neurologically, there may be decreased palpability and tenderness of the carotid artery on the side contralateral to the weakness; and ipsilateral Horner's syndrome may be present.

Syphilis, hypertension, brain tumor, and congenital and acquired diseases of the vascular and hematologic systems, as well as multiple sclerosis, must be considered in the differential diagnosis.

Most spontaneous (arterial) strokes in the healthy young are due to solitary atheromatous plaques. Stress may precipitate attacks in some cases.

Acute Intermittent Porphyria with Respiratory Paralysis. S. G. Doll.,* A. G. Bower, and J. E. Affeldt. J.A.M.A. 168:1973 (Dec. 13) 1958. (*13001 Paramount Boulevard, Downey, Calif.)

The recognition and diagnosis of intermittent

Abstracts

porphyria is frequently overlooked. The authors describe three cases with respiratory involvement. The histories, clinical and laboratory findings, and treatment are discussed in detail. It is emphasized that, although respiratory paralysis is present and although recurrent episodes and indeed persistence of high porphyrin levels may occur, it is possible to tide the patient over the period of respiratory failure due to paralysis of the respiratory muscles by use of a mechanical respirator. Accumulated secretions in the airway, due either to bulbar paralysis or to inadequate cough, can be treated by tracheotomy, thus bypassing the obstructive material in the hypopharynx.

The authors stress that needless surgery and needless and even harmful drug administration—for example barbiturates—have aggravated the condition. The disease is an inherited one, and frequently a good history will make the diagnosis even before the urine porphobilinogen test is done. Pending better understanding of the disease and of its control, the respirator is invaluable as a supportive agent to forestall what otherwise would be certain death in those cases with respiratory paralysis.

A Rapid Quantitative Method for Chemical Estimation of Urinary Catechol-Amines in the Diagnosis of Pheochromocytoma. J. T. Wright.* Lancet 2:1155 (Nov. 29) 1958. (*J. T. Wright, London Hospital, London, England)

Catechols form strongly acidic complexes with borate ions and can be extracted from solution with basic resins. The resin used in this study was "Dowex" 2 anion-exchange resin, and the test is done on 24-hour urine samples. The method is quick and economical and appears to be a good screening procedure in hypertensives.

Urine samples from 69 hypertensives were examined by this method. High urinary catecholamines, indicating the presence of pheochromocytoma, were found in six, and the diagnosis was confirmed at operation in each. Duplicate estimations on some specimens were made by the Weil-Malherbe chemical method, and Floyer's pressor test in the rat. The results showed general agreement.

The author gives detailed instructions of the material and method used, and tabulates the 24-hour catecholamine excretion in each of the six proved cases of pheochromocytoma.

The Electrocardiogram in Neurocirculatory Asthenia (Anxiety, Neurosis or Neurasthenia): A Study of 203 Neurocirculatory Asthenia Patients and 757 Healthy Controls in the Framingham Study. W. B. Kannel,* T. R. Dawber, and M. E. Cohen. Ann. Int. Med. 49:1351 (Dec.) 1958. (*123 Lincoln St., Framingham, Mass.)

The present study was undertaken to determine whether electrocardiographic abnormalities found in patients with neurocirculatory asthenia occur with the same or different frequency as in a similar group without neurocirculatory asthenia. All subjects with heart disease or hypertension were excluded from the study.

The criteria for the diagnosis of neurocirculatory asthenia were as follows: (1) The subject must have a respiratory complaint, such as sighing respiration, inability to get a deep breath, smothering, choking or dyspnea; (2) the subject must also have one or more symptoms from two of the following groups: I. palpitation, chest pain, or chest discomfort; II. nervousness, dizziness, faintness, discomfort in crowds; III. undue fatigability or limitation of activities.

The conclusions were that no characteristic electrocardiographic abnormalities are associated with neurocirculatory asthenia, no abnormalities characteristic of, or suggestive of, heart disease occur in uncomplicated neurocirculatory asthenia, and, finally, the same types of electrocardiographic abnormalities occur both in neurocirculatory asthenia and in healthy controls in the same frequency.

The Diagnosis of Gout Significance of an Elevated Serum Uric Acid Value. J. C. Goldthwait,* C. F. Butler, and J. S. Stillman. New Eng. J. Med. 259: 1095-1099 (Dec. 4) 1958. (*Robert Breck Brigham Hospital, Boston, Mass.)

Patients occasionally are encountered with an elevated serum uric acid lacking the criteria for the diagnosis of gout; that is, attacks of acute arthritis which in early stages are followed by complete remission, usually in males 30-50 years of age, often with a family history of gout.

The authors studied 225 patients with elevated serum uric acid (6 mg. per 100 ml. or greater). Of the total group, with hyperuricemia, 113 were diagnosed as having gout. The remaining 112 had either some well defined entity other than gout, such as, typical rheumatoid arthritis, atypical rheumatoid arthritis or rheumatoid arthritis associated with psoriasis, or had nonspecific symptomatology and findings which could not be accurately diagnosed. Kidney disease, polycythemia, neoplastic diseases of the bone marrow may be responsible for elevated serum uric acid. High levels may also occur in non-gouty relatives of gouty patients, and finally, various authors have found hyperuricemia to be present in the general population.

In atypical cases presenting with elevated serum uric acid, there is no easy method of diagnosis, such cases require continued observation, and consideration of the diseases mentioned above as the possible cause of the hyperuricemia. In the present study, less than one-half had characteristic gouty arthritis, and a wide variety of other conditions made up the remainder.

Analysis of the Precipitation Test for Systemic Lupus Erythematosus. C. M. Pearson.* J.A.M.A. 169:30 (Jan. 3) 1959. (*University of California School of Medicine, Los Angeles)

It was recently reported that a serum precipitation test was frequently positive in systemic lupus erythematosus. The author reports on a reevaluation of this test. Patients with other diseases than lupus erythematosus were tested. These diseases included various forms of rheumatic and connective tissue disorders including gout. The patients with lupus all had the disease substantiated by the presence of L.E. cells in the past or present, or by history and autopsy evidence of renal or other characteristic anatomical findings. Only 25% of 25 patients with lupus showed a positive test, while 32% of patients with rheumatoid arthritis had positive results. A small group of patients with rheumatoid spondylitis were tested, and 53% gave positive findings.

It is concluded that the serum precipitation test, using p-toluenesulfonic acid as the test reagent, as a specific for lupus erythematosus cannot be confirmed; in fact, six other rheumatic diseases in this series showed a greater positive incidence than did lupus erythematosus.

Experimental Toxicology

Robert E. Eckardt, Ph.D., M.D.

Licking as a Factor Affecting Dosage in Skin Carcinogenesis. B. A. Booth* and R. K. Boutwell. Cancer Res. 19:78 (Jan.) 1959. (*University of Wisconsin, Madison)

The fate of amounts of C^{14}-labeled 9,10-dimethylbenzanthracene (DMBA), varying from 4-1,000 μg in benzene or benzene-mineral oil mixtures was determined after a single application to the skin of mice. It was found that the loss attributed to licking is increased with increasing doses of DMBA and by replacement of half of the benzene with mineral oil. Skin absorption of DMBA, measured at the end of 0.5, 1, and 3 hours, decreased by increasing the dose of DMBA and by displacing half of the benzene with mineral oil. Thus, if the amount of carcinogen applied to the skin is sufficiently small, the effective dose approaches that which is applied.

Pharmacologic and Toxicologic Studies on N,N-Diethyltoluamide: I. N,N-Diethyl-m-Toluamide. A M. Ambrose.* Toxicol. & Applied Pharmacol. 1:97 (Jan.) 1959. (*Army Chemical Center, Md.)

Since m-DET is an outstanding insect repellent, its present use on the skin of man and in the treatment of wearing apparel may be extended to use in cosmetics, food containers, and wrappers. Thus, study of the physiologic effects was made in detail. The acute oral LD_{50} for rats is 2.0 cc/kg. I.v. doses of 50 mg/kg are not fatal in rabbits, but doses of 75 mg/kg are rapidly fatal. However, five daily injections of 25 mg/kg produced no cumulative toxic effects. Although single dermal applications of 2 or 4 cc/kg held in contact with depilated intact or abraded trunks of rabbits for 24 hours produced mild to moderate erythema, they did not produce systemic toxicity. Repeated dermal applications for 13 weeks did not cause systemic toxicity but did cause mild to moderate dermal irritation, desquamation, coriaceousness, dryness of the skin, and fissures, which cleared up within three weeks of the last application. A 50% solution applied to the face and arms of five volunteer subjects for five consecutive days and to one subject for three consecutive days for six weeks caused some irritation and desquamation about the nose. Following dermal application, no sensitization was observed in guinea pigs. Although instillation into the eyes of rabbits did cause corneal damage, it was not permanent. Inhalation caused no systemic toxic reactions. Ingestion of 0.01%, 0.05%, 0.1%, 0.5% and 1% in the diet for 200 days caused no signs of toxicity in rats.

Lithium Studies: 3. Distribution Between Serum and Tissues. M. Schou.* Acta Pharmacol. et Toxicol. 15:115 (Dec.) 1959. (*Aarhus University, Risskov, Denmark)

Measurement of lithium concentrations in rat tissues at intervals ranging from 15 minutes to 48 hours after intravenous injection of lithium chloride indicates that it passes rapidly from blood into kidney, more slowly into liver, bone, and muscle and very slowly into brain. In liver and muscle, the tissue/serum concentration ratios eventually reached constant levels, indicating that in these tissues equilibria had been established between intracellular and extracellular lithium concentrations. In both tissues the ratio of intra- to extracellular lithium concentration differed significantly from 1.00, being in liver equal to 0.36, and in muscle, equal to 2.15. Lithium is therefore not, as surmised previously, distributed evenly across the cell wall.

The Toxicity of Epiclorohydrin Vapor. J. C. Gage.* Brit. J. Indust. Med. 16:11 (Jan.) 1959. (*I.C.I.)

Daily six-hour exposures to epichlorohydrin vapor for a total of 11 to 19 exposures induced lung edema and damage to renal cortical tubules in rats at a concentration above 100 ppm. Above 50 ppm, marked nasal irritation was induced, and this did not disappear in either rats or rabbits until concentrations were reduced to less than 10 ppm. An MAC of 5 ppm is proposed. A "perspex" exposure chamber housed in a glass-walled chamber is routinely used, providing complete visibility and ease of cleaning and preventing contamination of the laboratory air. Test atmospheres are generated by means of a controlled fluid-feed atomizer.

An Experimental Analysis of the "Hair Cycle Effect" in Mouse Skin Carcinogenesis. I. Berenblum,* N. Haran-Ghera, and N. Trainin. Brit. J. Cancer 12:402 (Sept.) 1958. (*Weizmann Institute of Science, Rehovoth, Israel)

Skin painting studies in Swiss mice with 9,10-dimethyl-1,2-benzanthracene in benzene suggest

that the "hair cycle effect" (more tumors induced when carcinogen is applied during resting phase of hair cycle growth than when in growth phase) is due to an unduly short retention of adequate concentration of carcinogen in the deeper spaces of the hair follicles at the growth phase. The result is that there is insufficient amount present for effective promoting action. The difference in tumor induction observed for the two phases is not due to a difference in responsiveness of the tissues during the two phases. The carcinogen is apparently quickly flushed out by sebum secretion during the growth phase, whereas it persists for a long time during the resting phase. When hair follicles are completely absent, there is no repository for the carcinogen and consequently tumor response is less.

Toxicologic Research on Trimethylbenzene. K. Battig,* E. Grandjean, L. Rossi, and J. Rickenbacher. Arch. Gewerbepath. u. Gewerbehyg. 16:555, 1958. (*Zurich, Switzerland)

In a study of the effects of trimethylbenzene, 27 workers exposed only to that solvent in concentrations of 10 to 60 ppm showed a hyperchromic anemia (normal hemoglobin with red cell count less than 4,500,000/cu.mm). A majority also showed chronic asthmatic bronchitis, a tendency toward spontaneous bleeding, and depression of the central nervous system. In animal experiments, rats exposed to 1,700 and 500 ppm did not show hematopoietic system effects with the exception of a relative lymphopenia and neutrophilia. They did show an increased intake of water, diuresis, and severe injury to the central nervous system. Rats exposed to as little as 200 ppm showed free, total, and bound phenols in the urine. At autopsy the lungs showed thickening of the alveoli and the liver a fatty degeneration. In view of these findings, the authors recommend an MAC of 35 ppm for trimethylbenzene.

Effects of Restraint on Oxygen Consumption of the Cold Exposed Guinea Pig. R. G. Bartlett, Jr.* J. Appl. Physiol. 14:46 (Jan.) 1959. (*National Institutes of Health, Bethesda, Md.)

The oxygen consumption of cold-exposed, retrained guinea pigs is significantly greater than that of cold-exposed, nonrestrained controls. These and other studies reported in the literature suggest that hypothermia which accompanies restraint in the cold is due to an increased rate of heat loss rather than to a decreased muscular activity and consequently lessened heat production. The marked physiological changes accompanying retraint of small laboratory animals should serve as a warning to the investigator who uses restraint for convenience in data collection.

Studies of Chronic Exposures of Dogs to GB (Isopropyl Methylphosphonofluoridate) Vapor. K. H. Jacobson,* M. K. Christensen, I. A. De Armon, Jr., and F. W. Oberst. A.M.A. Arch. Indust. Health 19:5 (Jan.) 1959. (*Army Chemical Center, Md.)

Although the mild toxic effects produced in dogs exposed to GB (Sarin) vapor for 6 months at a daily Ct of 10 mg/min/cu.meter were more pronounced with seven-day/week exposures than with five-day/week exposures, they were less pronounced for four-hour/day exposures to a concentration of 0.04 mg/cu.meter (0.007 ppm) than for 20-min/day exposures to a concentration of 0.5 mg/cu.meter (0.09 ppm). There was no interaction between number of exposures per week and daily exposure time. Effects included a continuous miosis, progressive RBC-ChE inactivation (leveling off at about 30% of normal after the first few weeks), and occasional salivation, rhinorrhea, dyspnea, and lung changes. There appeared to be a correlation between RBC-ChE inactivation frequency and severity of other toxic effects. Recovery was complete after several months, with the RBC-ChE regenerating at a rate of 1%/day.

The Effect of Selenium on Vitamin E-Deficient Rats. F. Christensen,* H. Dam, I. Prange, and E. Sondergard. Acta Pharmacol. et Toxicol. 15:181 (Dec.) 1958. (*Polytechnic Institute, Copenhagen)

Experiments with rats have shown that 1.4 ppm selenium dioxide in the diet cannot prevent the following vitamin E-deficiency symptoms: decreased vitamin A liver storage; peroxidation of depot fat; brownish discoloration of depot fat; brownish discoloration of the uterus; depigmentation of the incisors; in vitro hemolysis of erythrocytes; and impaired reproduction capacity of females. Rats given a methionine-supplemented vitamin E-deficient Torula yeast diet died with signs of hemoglobinuria. Selenium dioxide and d,l-alphatocopherol acetate protected against this symptom.

Reparative Surgery

Robert J. Trettin, M.D.

Iatrogenic Stiff Shoulders. Robert G. Thompson* and Edward L. Compere. J.A.M.A. 169:945 (Feb. 28) 1959. (*720 N. Michigan Ave., Chicago 11)

All patients who have arm injuries which do not involve the shoulder joint should be instructed by the treating physician to carry out definitive exercises of the shoulder joint several times each day. The prevention of shoulder stiffness after injuries of the forearm and hand treated by slings or casts or other shoulder immobilization devices requires the active cooperation of each patient. This is accomplished by definitely instructing each patient in a very simple, short exercise of the shoulder, to be performed several times each day. Each of 11 patients in a total group of 130 patients who were treated at the Chicago Rehabilitation Center was found to have varying degrees of stiffness or fibrous ankylosis of the shoulder joint after an injury to the distal part of the arm. This stiff and painful shoulder complication could have

been prevented. Physicians should try not to commit sins of omission just as they try to avoid sins of commission.

Simple Regional Nerve Block for Surgery of the Hand and Forearm. Preston J. Burnham.* J.A.M.A. 169:941 (Feb. 28) 1959. (*508 E. South Temple, Salt Lake City, Utah)

The author describes a method of regional nerve block employed in a series of 52 patients for major surgical procedures in the hand which appears to meet the following criteria: certainty of result; ease of administration; minimal danger of systemic toxicity and even of anaphylactic reaction if sensitivity is present; adequacy for major surgical procedures on the hand and forearm, with minor procedures safely performed under regional digital or regional wrist blocks; without danger in the presence of a full stomach, multiple injuries, or a crushed chest; avoidance of the complications of the supraclavicular brachial plexus block; and appropriate for rapid, sure, and safe administration in the event of mass casualties. This method relies upon an adequate systolic blood pressure for positive identification of the brachial artery just distal to the pectoralis major tendon.

Use of Intravenous Fat Emulsions in Surgical Patients. Frederick W. Preston* and George C. Henegar. S. Clin. North America 139:145 (Feb.) 1959. (*333 East Huron St., Chicago 11)

In a recent symposium of intravenous fat emulsions, there were 21 papers presented concerned with an improved fat emulsion containing 15 per cent cottonseed oil. The significance of this symposium is that a satisfactory intravenous fat emulsion has now had an extensive clinical trial and can be recommended for general use.

The authors review the physiologic effects of fat emulsions and discuss their limitations and toxic effects. They conclude that recent experience with the improved emulsion, containing 15% cottonseed oil, is a safe method of providing caloric supplements to surgical patients. The commonest unfavorable reaction to intravenous fat is fever. Prolonged use of the emulsion may lead to fat-overloading syndrome characterized by accumulation of fat in the liver and hypocoagulability of the blood. These seem to be the most serious side-effects.

Daily infusions of 600 ml. of the improved fat emulsion for 14 consecutive days are well tolerated, thereby supplying an additional 960 calories per day.

Studies in Metabolism of Trauma. J. U. Schlegel* and Hans Jorgensen. Ann. Surg. 149:252 (Feb.) 1959. (*University of Rochester School of Medicine & Dentistry, Rochester, N. Y.)

The authors present a new approach in the acute treatment of a burn patient. The method proposed is a physiological approach to the extremely complex situation resulting from thermal injuries. It is based upon the fact that urine volume is a function of solute excretion under the condition of antidiuresis as is present following a severe burn. This paper discusses the use of urea as a solute to promote osmotic diuresis.

By the administration of 4% urea in 5% dextrose-in-water solution, a diuresis can be maintained and established in patients with normal kidneys and normal blood pressure. Replacement therapy to satisfy the obligatory burn edema is accomplished by giving plasma, dextrose, or saline to maintain vital signs, while urinary output is maintained at a high level by the administration of 4% urea solutions. The principles applied offer a simplification of the initial phase in burn therapy which may be extremely useful if treatment of large numbers of such injuries under emergency conditions becomes necessary. Considerable improvement may also be achieved by further studies, since the requirement for sodium chloride appears to be minimized and renal damage and excessive edema may possibly be avoided.

Wounds of the Liver. Gordon F. Madding.* S. Clin. North America 38:1619 (Dec.) 1958. (*Stanford University Medical School, San Francisco)

Of the injuries involving abdominal organs, those of the liver may be the most difficult to treat because of the multiple problems involved in their proper care. The seriousness of an injury to the liver is dependent upon three factors: (1) error in diagnosis, (2) presence of associated lesions, and (3) improper therapy. The author discusses the essential points in diagnosis and management of the patient with a liver injury, emphasizing several principles. The traditional gauze pack for hemostatic purposes, which functions as a tampon and not a drain, should be avoided except as a temporary measure during the operation. The establishment of adequate external drainage of bile and products of tissue injury is the most important feature in the surgical care of all liver wounds. This includes the placing of drains within the liver substance proper when the occasion warrants.

Treatment of Facial Wounds. Douglas W. Macomber.* S. Clin. North America 138:1491 (Dec.) 1958. (*1800 High St., Denver 18)

Facial wounds afford incomparable opportunities for refined surgical technique, followed by unhampered observations and appraisal of results. Facial wounds provide superior opportunities for observation, training, and teaching of traumatic surgery. The author emphasizes the handling of tissues with utmost gentleness, instruments no heavier and suture material no larger than necessary to do the job. Avoidance of tissue-destroying chemicals, crushing, mass ligation, tension, and tight sutures is mandatory. Lightweight instruments, particularly small sharp hooks, are recommended.

Abstracts

Diagnosis is important in deep and extensive lacerations, just as in any other medical or surgical problem. The general condition and other injuries should be appraised and treated. No raw surface should be left unclosed or not covered with skin. Any wound can be closed without tension, utilizing local undercutting, local sliding or rotation skin flaps, or remote free skin grafts. No dressing upon an open wound is superior to skin.

Prompt healing of wounds will avoid or inhibit infection, minimize fibrosis, beget minimum scars, restore function, and simplify and facilitate definitive surgery when secondary operations are necessary or desirable.

Clinical Toxicology

Lee H. Miller, M.D., I.M.D.

Radiological Abnormalities in Chronic Pulmonary Disease Due to Beryllium. J. E. Gary* and R. Schatzki. A.M.A. Arch. Indust. Health 19:117 (Feb.) 1959. (*1180 Beacon St., Brookline, Mass.)

Cases with available chest x-ray films on record in the Beryllium Registry were reviewed. As a result of their studies, the authors question the concept that the x-ray pattern proceeds in an orderly sequence of stages (normal→linear fibrosis→granular→reticular→nodular) as has been postulated previously. They believe that lungs respond in one way or another to produce types of disease rather than stages of disease. Cases were observed in which a pure granular type of reaction persisted as long as six years, while other cases began as nodular disease and remained as such. A change from a granular to a nodular pattern was not seen in any case. Hilar and paratracheal adenopathy were seen in cases with granular, reticular, nodular, and pneumonic patterns. It is emphasized that serial films are of primary importance if an early diagnosis is to be made. No correlation between the x-ray appearance and the status of pulmonary function was noted. Marked radiological regression was observed; however, no case was found in which the x-ray picture reverted completely to normal. A differential diagnosis by radiological means alone is not possible. Numerous diseases may simulate berylliosis, and, of these, sarcoid, miliary tuberculosis, and silicosis are among those most easily confused with this disease. Reproductions of x-ray pictures and summaries of eight cases are presented.

Organic Mercury. B. D. Dinman,* E. E. Evans, and A. L. Linch. A.M.A. Arch. Idust. Health 18:248 (Sept.) 1958. (*Department of Preventive Medicine, Ohio State University, College of Medicine, Columbus)

The results of an apparently effective health control program based on a threshold limit of 0.1 mg. per cubic meter of air in the manufacture of organic mercurials are presented. Studies were carried out on 20 workers who had exposure to dust (ethyl mercury chloride or phospate adsorbed on inert clay) and liquid formulations (solvent solutions of ethyl or phenyl mercury acetate). Whenever an operator excreted more than 0.050 mg. of mercury per liter of urine, a weekly urine analysis was required. Removal from the exposure was effected when the urine concentration of mercury exceeded 0.100 mg. and a return to an exposure area was not permitted until two consecutive weekly urine determinations below 0.050 mg. were obtained. All workers received bimonthly and annual physical examinations and, in addition, a review of the systems was obtained each time a urine specimen was collected. Analyses of urine for mercury were carried out monthly on all potentially exposed workers, and weekly following accidental exposures, or when the urinary mercury level exceeded 0.100 mg. per liter.

Nonspecific symptoms elicited from the exposed populations did not appear to occur with greater frequency than would be expected in an unexposed population. Similarly, the results of the physical examinations and the clinical laboratory studies did not reveal any significant abnormalities. There was no correlation between the concentration of mercury in the environment and the monthly urinary excretion of mercury, and the excretion of mercury appeared to fluctuate irregularly. These observations, in addition to the fact that organic mercurials may be absorbed percutaneously, emphasize the inadequacy of a control program that relies solely on atmospheric sampling as a measure of the severity of the exposure. The authors conclude with the well-known maxim that "man himself serves as the ultimate sampler of the atmosphere in which he is exposed."

The Excretion of Hexylene Glycol (2-methyl-2,4-pentane diol) in Man. E. Jacobsen.* Acta pharmacol. et toxicol. 14:207 (May) 1958. (*Biological Laboratories of Medicinalco Ltd., Copenhagen S.)

Little is known about the toxicity and excretion of hexylene glycol, even though it has been recommended for use in foods, essences, and medical preparations. Five subjects participated in three series of experiments. In the first, single doses of hexylene glycol were given. In the second, 5 gm. (2.5 gm. twice daily) was given, while in the third series, 1 gm. of hexylene glycol was given daily for 8 to 11 days followed by 2 gm. daily for 13 to 14 days. No abnormalities of the urine were found, and none of the experimental subjects had experienced subjective symptoms that could be attributed to the intake of hexylene glycol. The excretion of this chemical from the body via the urine occurs slowly. An equilibrium between intake and output is established after a few days, provided the intake does not exceed 2 gm. daily. Elimination may occur for 5 to 10 days after ingestion and approximately 20% to 25% is excreted in the conjugated form.

Aseptic Necrosis of Bone in Caisson Disease. J. D. Thomson* and A. B. Young. Brit. J. Indust. Med. 15:270 (Oct.) 1958. (*The Royal Infirmary, Glasgow)

Necrosis of bone as a manifestation of decompression sickness has been recognized for a long time; however, it is not common. Lesions involving the shaft and lower end of the femur, the upper end of the tibia, the humerus, femoral head, shoulder, and other joints have been reported.

A case of decompression sickness is presented. The patient had worked 12 hours a day for 5 days at a pressure of 15 lb/sq. in. He was allowed out of the chamber for two 20-minute periods each day. After an interval of 48 hours, he worked an 8 hour shift under a pressure of 20 lb/sq. in. Approximately three hours later he had severe pains in the upper portions of the arms, both hips, the right knee, and the mastoid area. He worked in the caisson for two additional days with the aid of codeine for pain. A week later the pain had disappeared from all areas except the right hip. Over the next two years he became increasingly crippled by the pain in the hip and apparent weakness of the right leg. On examination, movements of the right hip were restricted. The x-ray film of the hip showed a sclerotic area involving the inferior aspect of the head and upper part of the neck of the right femur which was interpreted as being consistent with the appearance of avascular necrosis.

Since the bony lesions, depending on their location, may be asymptomatic, the authors believe that more radiographs of the areas in which pains during the "bends" are experienced may result in earlier recognition of the lesion and a more accurate assessment of its incidence.

Industrial Hygiene

Edward C. Riley, M.D.

Clinical Investigation of Spray Painters (Varnishers). F. Bister,Dlavis-Hannover, G., Kohler-Wien, H., and Wittgens, H. Arch. Gewerbepath. u. Gewerbehyg. 16:567 (Sept.) 1958.

The authors felt that the increasing use of zinc chromate paints combined with the increasing evidence in scientific literature that this material can be hazardous, justified a clinical investigation of spray painters (varnishers). Although the investigation proved inconclusive as far as specific toxicity is concerned, they felt that certain observations were worth noting. The zinc chromate colors which were used by the spray painters seemed to cause marked changes in the respiratory mucous membranes which they believed was, at least in part, due to the phthalate-containing binder as well as the zinc chromate itself. Also the urinalysis showed some increase in chromium although the chrome content was not as high as the observations by Spannagel and Lowen in the chromate manufacturing industry.

They feel that the spraying of the chromate-containing paints should be carried out only with good personal protection, including supplied air respirators and routine medical supervision. Medical supervision should include regular observations of the nose and throat, analysis of the urine for excretion of chromate and yearly chest x-ray examinations. They also recommended replacing the phthalate binder with a less irritating material and suggest that further studies should be carried out to evaluate the hazards from welding, burning, cutting, and riveting metals which have been protected with chromate primers.

[NOTE: Dr. E. K. Chaffee translated the original German article for the abstracter.]

Beryllium Diseases and Its Control: Conference Held at the Massachusetts Institute of Technology, Sept. 30-Oct. 1, 1958. A.M.A. Arch. Indust. Health 19:91 (Feb.) 1959.

The last seven articles of this symposium relate specifically to industrial hygiene control and probably can best be reported as a group. The authors and titles of these articles are as follows:

1. E. C. Hyatt, H. F. Schulte, R. N. Mitchell, and E. P. Tangman Jr.: Beryllium: Hazard Evaluation and Control in Research and Development Operations, p. 213.
2. H. M. Donaldson: Problems in the Control of Operations in the Beryllium-Processing Plant, p. 221.
3. A. Epstein: Problems in the Safe Operation of Certain Beryllium-Using Processes, p. 225.
4. R. J. Chamberlain: The Control of Beryllium Machining Operation, p. 231.
5. F. J. Viles, Jr.: Review of Control Problems in Operations Using Various Beryllium Compounds, p. 239.
6. L. Silverman: Control of Neighborhood Contamination Near Beryllium-Using Plant, p. 254.
7. C. R. Williams: Evaluation of Exposure Data in the Beryllium Registry, p. 263.

In all of the industrial hygiene control programs reported, the standards established by the AEC in 1951 for beryllium have been used as the objective in control pf personnel exposures. For in-plant exposures these are an average daily exposure for an eight-hour day of less than 2 $\mu g/^3$ with no single exposure greater than 25 $\mu g/m^3$ even though the over-all exposure for the day might still be within the 2 $\mu g/m^3$ limit. For environmental or neighborhood contamination, the value of 0.01 $\mu g/m^3$ has been recognized. Through extremely careful engineering and meticulous housekeeping and training programs, most of the organizations using beryllium have been able to keep well within the accepted standards, and whenever by reason of process or equipment breakdown the levels have been exceeded, personal protective equipment has been utilized to protect personnel. No attempt has been made to discriminate between beryllium metal, beryllium oxide, and other beryllium salts in respect to the allowable exposure. In spite of the fact that few

materials used in industrial processes have presented greater industrial hygiene problems, there seemed to be a generally optimistic impression that these problems were currently being adequately controlled. It may be fortunate that in many instances not only is there a potentially serious beryllium exposure but there are other chemical and radiation hazards which require careful control both in the plant and in the community. Mr. Donaldson summarizes the type of planning that is required for any one who is considering processing beryllium.

1. Location of plant site must be carefully selected.
2. Proper processes and equipment must be obtained to permit maximum control.
3. Adequate local exhaust ventilation and air-cleaning equipment must be provided.
4. Provision for preventing contamination of employees' homes by beryllium unknowingly carried out of the plant.
5. Special precautions to protect the skin of workers handling beryllium and its compounds.
6. Training program for new employees and a follow-up program for old employees.
7. Air-sampling program must be established for measuring the concentrations in the air inside the plant as well as in the community outside of the plant.

It is obvious that such an extensive program is a basic consideration in the production cost, and, in order to permit this to be successful, cooperation from every level in the organization is necessary.

Mr. Viles, in his review of the engineering problems of control, presents some theoretical considerations which are important to the industrial hygiene control program for the control of any toxic material but in this case are focused specifically on the beryllium hazard. In all of these discussions, it is reassuring to see the emphasis which has been placed on the need for continuing air sampling and inspection to be sure that the program is being carried out. It is both expensive and difficult to maintain a program of this sort, but, unless an adequate follow up is maintained, the program will inevitably fall short of its objectives. As has been brought out, this is perhaps where the cooperation of the entire organization is most needed and difficult to maintain.

Dr. Silverman, in discussing neighborhood contamination, compares the ratio of tolerable neighborhood exposures to the plant exposures for beryllium and several toxic materials. While the ratio of 200:1 for in-plant versus neighborhood exposures is somewhat higher than for most other toxic chemicals, it is not greatly different in order of magnitude. He also has outlined the steps necessary in selecting a site for a beryllium-using plant and methods for calculating plant emissions and stack heights.

Dr. C. R. Williams, in summing up the current MAC in relation to the beryllium registry, feels that the limits are relatively safe, probably conservative. However, he does not question the accepted working levels or allowable limits proposed by the AEC. He is critical of the value of 50 mg/m^3 suggested as "immediately hazardous to life" in the Hygienic Guide for Beryllium. Perhaps the program can best be summarized in Dr. Williams' own words: "Beryllium and its compounds are going to be used in our industrial economy. This conference has demonstrated two important points which should be emphasized. Excessive beryllium exposures are capable of producing a severe occupational disease which has a high mortality rate. By the use of proper engineering and medical controls beryllium and its compounds can be used safely."

Radiation Health

Thomas S. Ely, M.D.

Carcinoma of the Thyroid in Children After X-ray Therapy in Early Childhood. Donald R. Rooney* and R. Waldo Powell, J.A.M.A. 169:1 (Jan. 3), 1959. (*Department of Radiology, Emory University School of Medicine, Atlanta, Ga.)

Carcinoma of the thyroid in children is being diagnosed with increasing frequency. Several explanations have been offered to help explain this. Among these is the formerly prevalent use of x-ray therapy for benign childhood conditions. If a carcinogenic mechanism is involved we should expect a decrease in the incidence of this neoplasm in the future, as the practice of using irradiation for benign conditions in children is being abandoned. Also, if such a mechanism exists, it probably operates most strongly during infancy. Thyroid cancer after irradiation in adults is a rarity. Of 357 children with reported thyroid carcinomas, approximately one-third had received prior radiation therapy to the pharynx, neck, or chest for non-malignant conditions. Further studies are needed before definite conclusions are reached, and until that time children should be protected from ionizing radiation in the treatment of benign conditions. [Author's abstract]

Organic and Inorganic Urinary Excretion Values in Normal and Irradiated Subjects Including Observations on the Preservation of the Urine Sample. C. Sanders, P. C. Long, and D. H. Pinnock. Atomic Energy Research Eestablishment Report AERE/MED/R 2586, May, 1958. (Available from Scientific Administration Office, Atomic Energy Research Establishment, Harwell, Berkshire, England)

Incidents involving large overexposure to radiation, particularly if a group is involved, may cause serious overloading of urinalysis facilities if abnormal chemistry is investigated. Some scheme for preservation is needed, which will not alter the specimen with regard to the determinations to be made. Twenty-four-hour urine specimens from normal individuals were preserved by a 1% concentration of 10% thymol in isopropyl alcohol, followed by freezing at —20°C. Determina-

tions of chlorides, creatinine, urea, total nitrogen, and total amino-acid nitrogen at monthly intervals, showed no change over a three-month period. In the evaluation of the effects of radiation, it is very important to have preirradiation control specimens on the same individual. It is also important to use 24-hour specimens for all determinations. A study was made on the changes in chlorides, urea, creatinine, total nitrogen, total amino-acid nitrogen, and individual amino-acid patterns by paper chromatography on 10 patients who received from 9 to 57 megagram rads for various neoplasms. The changes that were noted were small and would not have been evident without preirradiation controls.

A Limited Survey of Radiation Exposure from Dental X-ray Units. R. O. Gorson,* R. M. Halvorsen, J. Lieberman, and E. V. Aitken. Radiology 72:1 (Jan.) 1959. (*Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia 4)

A survey of 56 dental x-ray units in Philadelphia by the Department of Health of the City of Philadelphia demonstrated a wide range of machine characteristics, patient dose, and dental personnel dose. The evaluation included the measurement of the air dose rate in the patient's position, the aluminum half-value layer (h.v.l.), the size of the primary beam, and the scatter and leakage. The dentists and x-ray technicians were monitored with film badges for one or two weeks. An evaluation of dosages was made from the above information and a record kept of the conditions of exposure and the number of exposures made. The data from each of the machines tested are presented; they demonstrate a wide range of exposures. Patients received from 0.4 to 15.8 r per molar roentgenogram, and technicians from 0 mr to a mean of 45 mr to a maximum of 1400 mr per week. Beam diameter ranged from 3.5 cm. to 12 cm., and the h.v.l. from 0.5 to 2.6 mm. of aluminum. To estimate the effect of filtration on film quality, unmarked films were evaluated by 8 radiologists and 10 dentists. Results indicate that a minimum of 2.0 mm. aluminum equivalent can be recommended without compromising quality. Other apparent recommendations are made with regard to beam size, film speed, and development time.

Radiation Exposure as a Reasonable Calculated Risk. Lauriston S. Taylor.* Health Physics 1.62 (June) 1958. (*National Bureau of Standards, Washington 25, D. C.)

Maximum permissible exposures for radiation workers have been based, in the main, on levels that would not produce detectable injury to any individual. The impossibility of correlating radiation effects with small radiation dosage makes it impracticable to use this criteria indefinitely. It must be assumed that there is some undesirable effect from radiation exposures, even though these are not specifically detectable. We are thus confronted with the necessity for accepting some risk due to radiation exposure, even though this risk cannot be specifically defined. The addition of a risk philosophy in the establishment of radiation protection standards and the acceptance of occupational exposure becomes a necessity, if we are to continue the proper exploitation of radiation as a servant to man. Some comparison of the risk due to various types of radiation exposure is given. [Author's abstract]

Current Status of the Internal Dose Problem. K. Z. Morgan.* Health Physics 1:125 (Sept.) 1958. (*Oak Ridge National Laboratory, Oak Ridge, Tenn.)

There are MPC values for many additional radionuclides in the revised handbooks (now ready to go to press) of the National Committee on Radiation Protection, NCRP, and of the International Commission on Radiological Protection, ICRP. The basic philosophy and principal standards used in obtaining these MPC values have not changed. The MPC values are calculated on the basis of a dose rate of 0.6 rem/week to the thyroid or skin, 0.56 rem/week to bone, 0.1 rem/week to the gonads or total body, and 0.3 rem/week to other organs of the body. In this revised edition the period of occupational exposure is 50 years (it was formerly 70 years). The GI tract is the critical body organ for more than 50 per cent of the 230 radionuclides listed in these publications. All MPC values are calculated on the assumption that the body burden of the radionuclides is an exponential function of time. In addition, in the few cases where sufficient data are available, calculations are made on the basis of a power function of time. [Author's abstract]

Hazards of Atomic Radiation. P. Alexander. The New Scientist 4:622 (Aug. 14) 1958.

The main conclusion of the Report of the UN Scientific Committee on the Effects of Atomic Radiation is that man-made radiation should be reduced because of genetic reasons. Although in most of the report there was unanimity among the delegates, Western members of the committee could not agree to the Indian position that all bomb testing be discontinued for health reasons. This is perhaps because fallout radiation assumes a relatively greater importance in the total radiation received by Eastern peoples, who depend on rice rather than milk and who receive small amounts of x-ray. Estimates of the effects of fallout to date vary from 2,500 to 100,000 mutations, and 0 to 2,000 cases of leukemia. The wide range is explained by the impossibility of direct research at such low incidence. A 1% incidence can be detected by experiment, while the region of interest is 100 times less than this. Four proposed curves of leukemia incidence vs. dose are presented. All are approximately linear except at the very low incidence and low dose region. All

fit existing data, which are above this low level. One curve is linear to the origin. One improbable curve indicates a disproportionately high incidence at very low dose. A third curve indicates a disproportionately low incidence at low doses or pseudothreshold, and a fourth intersects the abscissa at some positive value of dose, demonstrating a true threshold. The actual case is extremely important to know but is unknown at this time. It will never be discovered by animal experimentation on a direct gigantic scale, but may be by a better understanding of the involved basic mechanisms.

Noise and Hearing

Horace O. Parrack

Intensive Determinants of Remote Masking. Robert C. Bilger.* J. Ocoust. Soc. America 30:817 (Sept.) 1958. (*Central Institute for the Deaf, 818 South Kingshighway, St. Louis)

When a band of high-frequency noise, at a sound pressure level greater than 80 db. masks tones below and remote from the lower cut-off frequency of the band, the phenomenon is called remote masking. The relation of band width to remote masking was studied using these bands of noise: 250-5000, 500,5000, 1000-5000, 2000-5000 and 4000-5000 cps. The relation of remote masking to over-all level of the band was examined, using a 2000-6000 cps band as over-all SPL of 100 db, a 4000-6000 cps band at an over-all SPL of 97 db, and a 4000-6000 cps band at an over-all SPL of 100 db. The relation between remote masking and over-all level was studied, holding the lower cut-off frequency of the bands constant. In other experiments, constant remote masking was sought by varying band width and band intensity. The relations of spectrum level and of band width to remote masking are given by $L_r = 2L_s + L_t + C$, where L_r is remote masking in db; L_s is spectrum level in db; L_t is band-width level in db reference a 1-cps band width; and C is a constant, specific to each group of subjects.

Temporary Threshold Evaluation Produced by Continuous and "Impulsive" Noises. Walter Spieth* and William J. Trittipoe. J. Acoust. Soc. America 30: 523 (June) 1958. (*Operational Applications Lab., AFCRC, Bolling AFB, Washington, D. C.)

Frequently the work environments of military personnel and industrial workers will result in their exposure to noise which may be made up of continuous components and components consisting of repeated impulses. The authors have performed experiments to determine the relative effectiveness of continuous noise and noise of simulated "impulsive" character, spread over the same time intervals, in producing temporary hearing threshold shifts (TTS). One series of impulsive noises was a burst lasting 1 millisecond and occurring once in 10 seconds, 100 seconds, etc. when the total exposure was 20 minutes. In another series the burst of noise lasted one-tenth of the time; 1 second on and 9 seconds off, 10 seconds on and 90 seconds off, etc., during a total exposure time of 2 minutes. These impulsive noises were compared with continuous noises lasting 20 minutes or 2 minutes respectively and at 10, 20, or 30 db lower sound-pressure levels than the peak level of the impulsive bursts. The TTS produced was measured for 4000 cps in most cases, but TTS for 3000, 6000 and 8000 cps was also measured. In general, it was found that a quantity of acoustic energy applied as impulses produced a different amount of TTS than was produced by the same energy delivered continuously over 2-minute and 20-minute periods of exposure.

Effect of Noise on an "Intellectual" Task. D. E. Broadbent.* J. Acoust. Soc. America 30:824 (Sept.) 1958. (*Applied Psychology Research Unit, Cambridge, England)

Each of three groups of Royal Navy personnel devoted two sessions to a subtraction task that imposed a heavy, immediate memory load. One group worked in relative "quiet" (70 db) during both sessions. A second group worked in 100 db noise during the first session and in "quiet" during the second session. The third group worked in "quiet" during the first session and in noise during the second session. Thirty different problems made up the task, and time required to solve each problem was observed as the task progressed. The group that worked only in "quiet" continuously reduced this time on both days. The group that worked in noise the first day required a longer time to solve successive problems as time passed, and this effect persisted into the second (quiet) day. The group which worked in quiet the first day and in noise the second day showed retarded performance on the day of noise exposure. These results suggest that intellectual work is impaired by noise under appropriate conditions.

Intensity and Duration of Noise Exposure and Temporary Threshold Shifts. Walter Spieth* and William J. Trittipoe. J. Acoust. Soc. America 30: 710 (Aug.) 1958. (*Operational Applications Lab., AFCRC, Bolling, AFB, Washington, D. C.)

The temporary threshold shift (TTS) caused by exposure to sound frequently used to estimate the potential threat to hearing created by exposure to the sound. Twelve ears (six subjects) were exposed as follows: 130 db for 1 minute; 124 db for 2 minutes; 118 db for 4 minutes; 112 db for 8 minutes; 106 db for 16 minutes; 100 db for 32 minutes, and 94 db for 64 minutes. The TTS was measured for 10 minutes following the exposure in order to obtain information on the relative importance of sound level and duration of exposure in producing TTS. At five minutes after the exposures the TTS, for a test tone of

4000 cps, ranged between 9 db for 64 minutes of exposure to 94 db and 16 db for 16 minutes of exposure to 106 db or 32 minutes' exposure to 100 db. It was concluded that no rule about the relative of importance of sound level versus exposure duration would hold over a wide range of sound levels and durations.

Temporary Threshold Shift and Masking for Noise of Uniform Spectrum Level. James D. Miller.* J. Acoust. Soc. America 30:517 (June) 1958. (*Hearing and Communication Laboratory, Department of Psychology, Indiana University, Bloomington, Ind.)

Bands of noise are known to interfere with the detection of test tones of appropriate frequency. This interference or masking is produced by a limited band width of noise called the "critical band width." Noise of appropriate level also produces a temporary shift of hearing threshold (TTS). It has been suggested the "critical band" of a noise might be the effective portion in producing TTS. These experiments were performed to test the hypothesis that the "critical band" concept applies to the TTS-producing capability of noise. Subjects were exposed for 12 minutes to white noise of 95, 100, 105 and 110 db over-all sound pressure level. The TTS produced by these exposures was measured. The masking effects of the "critical bands" in masking and one producing TTS were compared. It was concluded that the effective noise level within the "critical band" cannot account for the TTS audiogram of white noise.

Mental Health

Graham C. Taylor, M.D.

The Executive Who Was Always Fair. P. Stryker. Fortune Magazine, P. 124, February, 1959.

The occupational physician frequently has to work in close cooperation with the personnel department on employee problems. These problems often include the notion of fairness—whether the employee has been treated fairly or not by his supervisor. One occasionally hears the admonition "be firm but fair," intended to be a guiding principle in this difficult area. In this article, there are examined certain aspects of the meaning of "fairness." This article is the sixth in a series of articles on executive qualities, and it is concerned with fairness on the part of an executive—a retired chairman. Specifically, the article is cast in a somewhat imaginative form, in which the retired chairman of a certain corporation had a reputation for fairness, reads his biography as written by an author of considerable experience on management matters, and complains that the biographer has underrated him as regards his fairness. The biographer, at the request of the publisher, replies in considerable detail, and the gist of the reply is that the executive was actually fairest when he appeared to be most unfair.

Abstracts

Industrial Psychiatry as Preventive Psychiatry. A. A. McLean. Psychotherapy 12:817 (Oct.) 1958.

The author, who is the psychiatrist to International Business Machines Corporation, points out in his introductory section that there are various approaches to industrial psychiatry, which is primarily preventive psychiatry. There can be a varying concentration on short-term therapeutic effects, upon educational efforts for industrial and supervisory personnel, and upon research. It is agreed that each industrial psychiatrist spends some time in employee evaluation, in educational efforts, in short-term psychotherapy, and in research activities.

The program at I.B.M. is now over a year old, and it is described under several headings. There is an interesting quote from Dr. Temple Burling, of Cornell University: "Psychiatry's role is to eliminate conditions in the working environment that aggravate internal conflict within the individual and block cooperative efforts." In this article, the writer discusses

1. Applied mental health research. This is concerned with examining those policies, procedures, and personalities which may cause unnecessary tension. He draws a parallel to industrial toxicology and argues that we should attempt to eliminate toxic factors.
2. The provision of the mental health educational service is discussed in some detail, particularly the executive development program of the company.
3. The provision of a consulting service for industrial physicians is also discussed.

He points out that the industrial physician is probably able to "help all but a very few of the psychiatric problems coming to the attention of his department."

The Executive Personality. E. Rosen. Personnel pp. 8-20, January/February, 1959.

This article is based upon interviews with 200 executives, who are interviewed and given some tests, which include the Minnesota Multiphysic Personality Inventory, The Richardson, Bellows, Henry Sentence Completion Test, and 12 cards of the Thematic Aperception Test (T.A.T.), as well as the Strong Vocational Interest Blank, and the Bernreuter Personality Inventory. Rosen points out that there are three types of executives in the companies studied, namely sales managers, production managers and scientific research personnel.

The executives tended to be more intelligent and generally less neurotic than the average. They also showed "marked defensiveness, strong control, relative lack of insight into themselves and their motivations, and a tendency to shy away from too much self-analysis." The executive values work for its own sake, is generally tactful and "nice" to other people.

Abstracts

The executive identifies strongly with the organization. He believes strongly in competition and is ambitious. He has also great faith in communication, employing the memorandum and meetings very frequently.

Specific personality traits are the following: (1) extroversion; (2) dichotomous thinking—situations are perceived as either good or bad, white or black with no intervening shades; (3) the executive is usually independent of his mother; (4) he usually admires, but wishes to surpass, his father; (5) he is optimistic and self-confident; (6) he stresses being practical; (7) he can tolerate frustration but not ambiguity, and (8) he is predictable.

From the foregoing considerations the author infers that the executives are vulnerable to certain mental health difficulties. The defense mechanism used is chiefly that of denial. There is an ever-present fear of failure. The behavioral disturbances which result are often psychosomatic—gastritis, ulcers, or skin ailments. Secondly, there is a tendency toward hysteroid behavior, such as a bland unwillingness to face certain situations. In general, the executive handles his problems fairly well. There are problems due to social mobility, but these he usually works out on his own.

In conclusion, the author speculates that the executive has the characteristics which are found in the general population, but only more so.

The author is also aware of the difficulty involved in deciding whether or not these executives' personalities led the executives into an executive career, or whether, on the other hand, they were developed as a result of the experience of living the executive role.

Key Factors in Effective Foreman Behaviour. B. R. Kay. Personnel pp. 2531, January/February, 1959.

This article represents a study of foreman behavior in a plant of approximately 600 employees, with a view to developing procedures to evaluate foreman performance. Based upon the analysis of the respondents statements, the following critical requirements appeared: Competence in administrative matters: (1) operations, (2) following instructions, (3) attention to details, (4) adherence to company policy, (5) selection of work for active supervision, (6) willingness to assume responsibility, (7) tact; Competence in supervising subordinates: (8) development of subordinates, (9) correction of undesirable behavior, (10) giving credit where due, (11) equality of treatment, (12) concern for employees' welfare, and (13) keeping subordinates informed; Relations with equals and superiors: (14) adherence to chain of authority, (15) acceptance of criticism and suggestions, and (16) communication with equals and superiors.

Perhaps of special interest, from the point of view of mental health, is the criterion of correction of undesirable behavior, under the heading of competence in supervising subordinates. However, no attempt is made to define what is meant by undesirable behavior.

Secondly, under the heading of relations of equals and superiors, there is a criterion of communication with equals and superiors, and here it appears that the author gives an oversimplified statement which indicates that, "one mark of the ineffective foreman is his failure to pass along information to the right people at the right time."

The Managerial Mind. C. E. Sumner Jr., Harvard Business Review 37:69 (Jan./Feb.) 1959.

The author of this article is concerned with attempting to define whether or not there is a "managerial mind" in a sense similar to that in which we may speak of the "legal mind" or the "scientific mind." He deals only with the intellectual qualities of the managerial mind, although he says: "Indeed, from time to time, the non-intellectual qualities may be a good deal more important than the intellectual ones, both from the point of view of the company and of society at large." The features which may go to make up the managerial mind are as follows:

A. Empirical qualities
1. The factual attitude
2. The quantitative attitude

Concerning the former, he points out that, although the administrator may need to get as many facts as possible, he can fall by the wayside if he waits too long to get all of the facts. Furthermore, not all of the facts can be known

B. Logical qualities
1. The theoretical attitude
2. The predisposition for truth
3. Consistency

He points out here that the businessman, as far as a theoretical attitude is concerned, should avail himself of theories of others but also should be able to abandon any theoretical formulation if it does not fit his specific problem. He suggests that the executive can find helpful the operations researchers, a "model" of the firm, and so forth. He goes further to suggest that business leaders and business schools should support the kind of training, both in logic and in semantics, that favors "theory spinning."

C. Qualities of action
1. Desire to change things
2. Timely action
3. Judgmental qualities
4. Suspicion of science
5. Objectivity in values

An executive has to face immediate problems and obtain immediate results, and this prevents him from following the scientific method too rigorously. The author, however, is recommending that the executive should take an interest in operations research and the current progress in social science.

About the Authors

JAMES H. STERNER, M.D., is author of Part II of the panel discussion on Certification in Occupational Medicine. Dr. Sterner is Medical Director of Eastman Kodak Company, Rochester, New York. He fills a long list of other posts, from which we presume to select four as being next in importance: he is consultant in industrial medicine to the U.S. Atomic Energy Commission, a member of the American Medical Association's Council on Industrial Health, associate professor of medicine at the University of Rochester, and a trustee (for occupational medicine) of the American Board of Preventive Medicine.

Following graduation from Harvard Medical School in 1932, Dr. Sterner interned and later trained in internal medicine at Lankenau Hospital, Philadelphia. In 1934 he organized the Laboratory of Industrial Medicine of the Eastman Kodak Company. He became Associate Medical Director of that company in 1949 and Medical Director in 1951.

Dr. Sterner was early and prominently identified with the health aspects of nuclear radiation. On partial leave from his duties in Rochester, he became the first medical director at Clinton Engineer Works, operated by the Tennessee-Eastman Corporation for Manhattan Engineer District. Another part-time war assignment was that of medical consultant to Holston Ordnance Works.

Dr. Sterner's early work at his company's Laboratory of Industrial Medicine produced practical solutions to the problem of sensitization dermatitis from chemicals used in the production of colored photographs. A second contribution to the advancement of prevention as a science in the chemical industry was his scheme of systematic observations of presumably well and symptomless workers exposed to a host of synthetic organic compounds, based largely upon subtle hemogram changes which are demonstrable only on adequate statistical analysis.

Dr. Sterner is a past president of the American Academy of Occupational Medicine and a recipient of the Industrial Medical Association's Knudsen Award.

ADOLPH G. KAMMER, M.D., author of Part III of the panel discussion on Certification in Occupational Medicine, is the editor of this journal. He is Professor of Occupational Health and head of the Department of Occupational Health in the Graduate School of Public Health, University of Pittsburgh; medical consultant to Union Carbide Nuclear Company and to Westinghouse Electric Corporation; and a trustee, for occupational medicine, of the American Board of Preventive Medicine.

Dr. Kammer is a graduate of the University of Wisconsin, from which institution he received the B.A. and M.S. degrees. He received the M.D. degree from the University of Pennsylvania School of Medicine in 1928 and thereafter interned at the Philadelphia General Hospital. After four years in general country practice he entered industrial practice with the Montreal (Wisconsin) Mining Company. In 1936 he initiated an industrial health program for Inland Steel Company and in 1938 became that company's Medical Director. In 1944 he went to Oak Ridge, Tennessee, as Medical Director of the gaseous diffusion plant operated by Carbide and Carbon Chemicals Company (subsequently Union Carbide Nuclear Company), and in 1947 was named General Medical Director of that company. His move to Pittsburgh occurred at the end of 1949.

Dr. Kammer has for many years been active in the affairs of the Industrial Medical Association, is one of its past presidents, and in 1958 received its Knudsen Award.

W. DAGGETT NORWOOD, M.D., is the author of the article in this issue entitled "The Determination of Injury from the Internally Deposited Radioactive Plutonium." He is Manager, Health and Safety, Hanford Atomic Products Operation, a facility of the Atomic Energy Commission located at Richland, Washington, operated by the General Electric Corporation; and he is chief of the industrial medical service at Kadlec Methodist Hospital in the same city. Dr. Norwood received the B.S. and M.S. degrees from Massachusetts Institute of Technology, following which he made a major change in his course of education and enrolled as a medical student at McGill University. He received the M.D. degree from the latter institution in 1935, following which he began a period of industrial medical service at various chemical plants of the Du Pont Company. When this company accepted responsibility for the operation of the first pile at Oak Ridge and for Hanford Engineer Works, Dr. Norwood entered a course of training in nuclear medicine at the University of Chicago and at Oak Ridge to prepare himself for medical service in the then entirely new atomic energy field. After the war, the General Electric Corporation accepted the management of the Hanford works. The name was then changed to Hanford Atomic Products Operation, and Dr. Norwood stayed on with the new managers in his present post.

Dr. Norwood is active on various committees within the AEC structure, as well as committees on radiation health problems of the Industrial Medical Association and the American Standards Association. He was a member of the board of directors of IMA, 1955-57. He is a fellow of the American Academy of Occupational Medicine, and is certified in occupational medicine by the American Board of Preventive Medicine.

Dr. GERALD GORDON is Chief of Psychiatric Section, Medical Division, E. I. duPont de Nemours & Company, and has been on the medical staff of this company since 1946.

He was born in Atlantic City, N. J., on May 23, 1909, and attended the Wilmington, Delaware, High School. Graduating from the University of Alabama in 1934, with a bachelor of arts degree, he continued there for two years in the School of Medicine. From 1936 to 1938 he studied at the University of Louisville School of Medicine, receiving his M. D. degree.

Folowing an internship at the California Hospital in Los Angeles, he went into private practice for two years. He volunteered for emergency medical service in England in 1941 and from 1942 to 1945 served as a medical officer in military psychiatric hospitals with the U. S. Army in England. Returning to Wilmington after the war he had a private psychiatric practice there for one year before joining the duPont medical staff.

Dr. Gordon is a member of the American Medical Association, the American Psychiatric Association, and the American Academy of Occupational Medicine. He is certified in occupational medicine by the American Board of Preventive Medicine.

JACK H. WOLFSIE, M.D., received his undergraduate and graduate education at New York University. He was granted his M.D. degree in 1939 and served an internship at New York Hospital. Following military service, he became interested in occupational medicine, a field in which he has since devoted his entire efforts. He is an active member of local and national professional organizations and was certified by the American Board of Preventive Medicine in Occupational Medicine in 1955. His present position is Director of Medical Services at the Warners Plant of the American Cyanamid Company, Linden, New Jersey.

C. BOYD SHAFFER, Ph.D., received his undergraduate training at Lebanon Valley College and his doctoral degree from Princeton University. For the first 11 years of his professional career he worked as a Fellow of the Chemical Hygiene Fellowship, Mellon Institute of Industrial Research, conducting biochemical and pharmacological investigations in connection with toxicity studies of synthetic organic chemicals. In 1952 he joined the Central Medical Department of American Cyanamid Company as Chief Industrial Toxicologist and organized and directed a laboratory for the study of the toxicology of company products. More recently he was appointed Director of Environmental Health, with responsibility for both toxicology and the central industrial hygiene program of the company. He is a member of the American Society for Pharmacology and Experimental Therapeutics, the American Industrial Hygiene Association, the Society for Experimental Biology and Medicine, and various other professional associations and is an author or co-author of a number of contributions to the literature in the fields of biochemistry and toxicology.

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People and Events

► CHARLES E. LEWIS, M.D., became Plant Physician of the Texas Eastman Company, a division of the Eastman Kodak Company, on May 15, it was announced recently by JAMES H. STERNER, M.D., Kodak Medical Director. Texas Eastman, which is located in Longview, Texas, produces polyethylene plastic and industrial chemicals.

DR. LEWIS joined Kodak in 1957 and since that time has been a member of the company's industrial medicine laboratory in Rochester, New York. He has specialized in the subjects of toxicology and industrial hygiene and has written several papers on these subjects.

He received a degree in chemical engineering from the University of Kansas and an M.D. degree from Harvard University in 1953. Later, he joined the Kettering Laboratory of the graduate school of the University of Cincinnati, where he earned a M.S. degree and is a candidate for a Doctor of Science degree this June.

DR. LEWIS served as a physician in the U.S. Air Force from 1954 to 1956. He is a member of the Industrial Medical Association.

► HARRY LAMB, M.D., has been appointed industrial health consultant for Tecumseh Products Company, Tecumseh, Michigan. His duties will be concerned with preventive medicine only. He will coordinate the health services of the company's main plant and subsidiaries, which include Lauson Engines in New Holstein, Wisconsin, Power Products in Grafton, Wisconsin, Taylor Products in Elkhart, Indiana, Acklin Stamping Company in Toledo and the Marion (Ohio) Division of Tecumseh Products.

HARRY LAMB, M.D.

DR. LAMB attended Georgetown University and obtained his M.D. degree from Georgetown Medical School in 1948. He interned at Harper Hospital in Detroit and subsequently served in the U.S. Air Force with the rank of Captain, from 1950-52. During the last seven years, he has practiced in Sturgis, Michigan, and has inaugurated medical programs for several small plants in that city.

► MAJOR R. T. P. DETREVILLE, of the Surgeon's Office at Headquarters, Air Materiel Command, Wright-Patterson Air Force Base, presented a paper at the 1959 Medical Conference recently held in Paris at the Supreme Headquarters, Allied Powers, Europe. The paper which was entitled, "Toxicity of Missile Fuels and Oxidizers Used in the Mace, Thor and Bomarc Weapons Systems," discussed the possible acute and chronic toxic effects of missile fuels on persons working closely with them. It also outlined medical diagnostic and therapeutic principles where acute or chronic toxicity is suspected.

DR. DETREVILLE serves as the Air Force Surgeon General's representative on the National Research Council's Committee on Toxicology. He is also a member of the Industrial Medical Association's Committee on Toxicology.

► FRANK L. FISHER, M.D., became Medical Director of the Crawfordsville, Indiana, plant of R. R. Donnelly & Sons Company, as of April 1. He was formerly associated with the Kingsbury Ordnance Plant located in La Porte, Indiana.

DR. FISHER is President of the Association of Ordnance Industry Physicians. He received his M.D. degree from McGill University Faculty of Medicine, Montreal, in 1924.

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People and Events

► The Industrial Medical Association of Pittsburgh will hold its spring meeting in Erie on May 22 at the General Electric Community Center.

R. B. NUTTER, M.D., Medical Supervisor, and NORMAN W. SEIP, Manager, Relations and Utilities Operation of General Electric's Erie Plant, will greet the guests. NORBERT ALBERSTADT, M.D., President of the Erie County Medical Society, will also deliver welcoming remarks.

The scientific papers to be presented include: "Use of the Terminal 'Ileum' in Urological Problems Involving the Ureter and Urinary Bladder" — Richard C. LYONS, M.D., Erie; "The Psychological Impact of an Economic Recession Upon the Mental and Emotional Status of Industrial Workers" — JAMES SUESS, M.D., Clinical Director, Warren State Hospital; "Capitalizing on Stress" — BEVERLY VOSBURGH, M.D., Health Consultant, General Electric Co., Schenectady; "The Industrial Physician's Role in Community Relations" — ROBERT ROSS, Director, Employee Service, General Staff, Ford Motor Company, Detroit; "The Need, Growth and Merits of Voluntary Health Insurance in a Free Economy" — GEORGE LEHMANN, Consultant, Employee Benefit Planning, General Electric Co., New York City.

A film entitled, "Millions on the Move," showing coordinated metropolitan transportation, will be presented by R. L. BOWERS of the Advertising and Sales Promotion Department, General Electric Co., Erie.

► The 1959 spring meeting of the Central States Society of Industrial Medicine and Surgery will be held May 24 at the Sherman Hotel in Chicago. The clinical scientific program will follow the Board of Governors meeting and the annual business meeting. Three papers will be presented by Chicago physicians. They are: "The Biochemical Physo—Pathology of Burns" — HARRY J. WEISBERG,; M.D., Assistant Professor, Department of Clinical Medicine, University of Chicago, School of Medicine, and Clinical Pathologist, Little Company of Mary Hospital; "Changing Concepts in the Modern Treatment of Burns" — JOHN G. BELL, M.D., Assistant Professor, Department of Surgery, Northwestern University, School of Medicine, and Attending Surgeon, Passavant Memorial Hospital; "Experiences in the Treatment of Burns in the Recent Chicago School Fire" — JAMES E. SEAGRAVES, M.D., Clinical Association, Department of Bone and Joint Surgery, Loyola University, Stritch School of Medicine, and

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► Western New York Society of Industrial Medicine and Surgery will hold its spring meeting June 6 and 7 at Glass Center, Corning, New York.

The scientific program includes the following papers: "New Developments in Glass" — GEORGE MCLELLAND, Coordinator of Technical Information Service, Corning Glass Works, Corning, New York; "Psychiatry in Industrial Accidents" — KENNETH KEIL, M.D., Director, Willard State Hospital, Willard, New York; "The Relationship Between Industrial Medicine and the General Practice of Medicine" — JAMES H. STERNER, M.D., Medical Director, Eastman Kodak Company, Rochester, New York; "Newer Concepts of Low Back Pain" — M. LAURENS ROWE, M.D., Chief Orthopedic Surgeon, Rochester General Hospital, Rochester, New York; "Training in Occupational and Aviation Medicine at Headquarters Air Materiel Command" — COL. P. E. WRIGHT (MC), USAF, Air Material Command, Wright-Patterson Air Force Base, Ohio; "Occupational Medicine as a Part of Comprehensive Medicine" — ROBERT BERG, M.D., Department of Preventive Medicine and Community Health, University of Rochester, Rochester, New York.

► At the annual meeting of the Michigan Industrial Medical Association held in Detroit on April 3, the following officers were elected: President — HAROLD H. GAY, M.D., Medical Director, Dow Chemical Company, Midland; President-Elect — DUANE L. BLOCK, M.D., Physician-in-Charge, Rouge Medical Service, Ford Motor Company, Dearborn; Vice President — RICHARD D. MUDD, M.D., Medical Director, Chevrolet Grey Iron Foundry, Saginaw; Secretary-Treasurer — HENRY J. KREULEN, M.D., Medical Director, Fisher Body Plant No. 1, Grand Rapids. The Board of Directors includes the four officers listed above and the three immediate past presidents, who are PETER B. RASTELLO, M.D., M. W. SHELLMAN, M.D., and EARL E. WESTON, M.D.

► On April 7, the Minnesota Academy of Occupational Medicine and Surgery, in conjunction with the

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People and Events

Minnesota League for Industrial Nursing, sponsored a joint meeting to which all physicians and nurses interested in industrial health services were invited. The dinner meeting was held at the Leamington Hotel, Minneapolis, with 120 physicians and nurses in attendance.

CLARENCE ROWE, M.D., St. Paul, psychiatric consultant to Minnesota Mining and Manufacturing Co., conducted a panel discussion of psychiatric problems related to occupational illness and injury. Other members of the panel were J. H. STRICKLER, M.D., Minneapolis, a surgeon; ROBERT MOONEY, M.D., St. Paul, an internist; and DR. SHIRLEY MINK, St. Paul, clinical psychologist.

► The Committee on Medical Aspects of Automobile Injuries and Deaths of the American Medical Association has just published in booklet form its "Medical Guide for Physicians in Determining Fitness to Drive a Motor Vehicle." This is reprinted from the *Journal of the American Medical Association*, 169: 1195 (March 14) 1959. The Industrial Medical Association has a supply of these booklets, and copies may be obtained by writing the headquarters office, 28 East Jackson Blvd., Chicago 4.

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